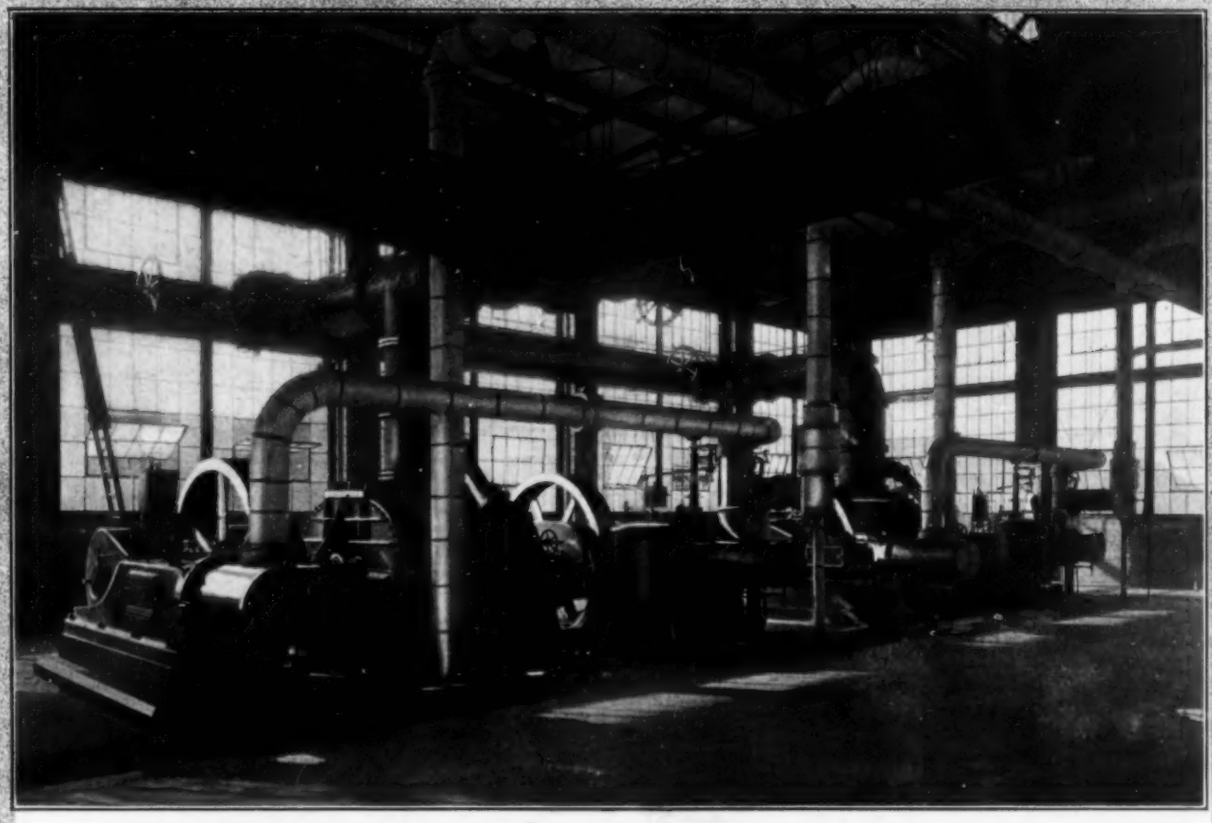
CHEMICAL & METALLURGICAL ENGINEERING

McGraw-Hill Co., Inc. November 30, 1921 25 Cents Per Copy



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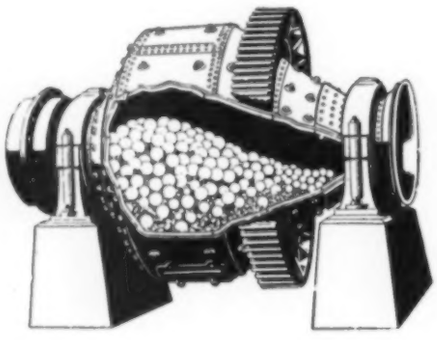

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Volume 25 — New York, November 30, 1921 — Number 22

Can Mild Steel Have 750,000 Lb. Ultimate Strength?

SOMETIMES theoretical reasoning leads to results of peculiarly "practical" significance. As an instance, in a recent number of the *Philosophical Transactions* of the Royal Society of London, A. A. GRIFFITH presented a study of "The Phenomena of Rupture and Flow in Solids," giving especial attention to the influence of cracks. Mathematical studies of the problem of elasticity are complex enough, one would think, without complicating the matter by analyzing the stresses in a cracked plate, and the results expressed in double integrations and partial differentations are absolutely unintelligible to almost all engineers. Fortunately, however, Mr. GRIFFITH, who is an engineer himself, interpreted his algebraic results into understandable words, and then commented upon their application to phenomena observed every day, but about which we really know very little.

His mathematics indicated that fatigue strength should be nearly independent of the depth of surface scratches. That is to say, a sharp bottomed scratch 0.0001 in. deep left by finest emery cloth should weaken a specimen about as much as a visible scratch of the same shape, a conclusion evidently at variance with carefully executed tests. Considering this discrepancy from many viewpoints, the author holds fast to the theoretical deduction that rupture in an isotropic elastic material always occurs at a certain maximum tension. In the limit, the maximum strength would be given by a single string of molecules, and should be from 1,000,000 to 1,500,000 lb. per square inch for hard glass. As a matter of fact such glass has an ultimate strength of 24,900 lb. per square inch when tested in small rods.

Here is a variation between theory and practice which would doubtless excuse the conservative and unimaginative from remarking, "That's about as close to the ground as those theoretical chaps ever get!" But it only urged GRIFFITH and his friends to redouble their efforts to bring the two into agreement. In fact, it was not long before he was able to prepare thinner and thinner filaments of this same glass bearing greater and greater and greater loads, until finally the perfectly amazing strength of 491,000 lb. per square inch was attained in a hair 0.0012 in. in diameter! Extrapolating to molecular dimensions, the maximum strength was estimated to be 1,600,000 lb. per square inch, a result which agrees with their theoretical deduction fairly well, considering the fact that one estimate was extrapolated and the other computed by the aid of approximate figures for surface tension of solid glass at room temperature.

A plausible reason for the comparative weakness of ordinary test specimens is that the usual tests impose stresses which are far from uniform, and that the non-uniformity of stress is similar to that set up were a supposedly homegeneous material full of minute flaws. Mathematical analysis again shows that these flaws should be relatively large as compared to molecules, having a width of the order of ten thousand times the molecular distances.

The nature of these "flaws" is somewhat speculative, since this size is large enough to be seen under a good microscope. At any rate, the author remarks that "the effective strength of technical materials might be increased ten to twenty times at least if these flaws could be eliminated." Perhaps Mr. GRIFFITH would regard the strengthening of metal by cold work—most commonly observed in high strength wires—as a suppression of flaws in metals; a conclusion somewhat at variance with accepted ideas as to the nature of cold work. Even so, his experimental results on glass filaments show that his theoretical deductions are within reason and his suggestions worthy of careful consideration. Soft iron having a strength of 750,000 lb. per square inch is a goal for the ambitious.

Canada and The Tariff

THE story is told of a body of Northern Indians that set out once upon a time on a long mush, resolved to follow the North Star until they came to the end of the world. So they marched and marched until finally they reached a great open place where there was nothing but ice and snow, where there were neither trees nor vegetation that they could see or use for tepees or where game might abound. It was a frozen desert where no man could live, and so it must be the end of the world. Then they turned back toward the south again.

There was also a troop of adventurous Esquimaux who likewise sought the end of the earth, and they set out to go as far as man could travel with the North Star directly back of them. And they went on and on until at last, after many weeks, they came to a place where the land was all covered with trees; where they could find no open plains and there was not snow enough to build an igloo for human habitation. It was a desert of woods and vegetation; there were neither seals nor polar bears nor any source of blubber. It was surely the end of the world, and so they turned back to the north again.

We like the story because the scene and *dramatis personæ* are suggestive of the United States and our friendly neighbor Canada. And we can imagine the Indians and Esquimaux crossing the international boundary in their search, that boundary which has been happily referred to as a "thin, invisible border which is not a line of division so much as one that shows where the United States and Canada are united." We like the idea. If Canada were in Siberia, we should not be united; as it is we are. We move backward and forward across the line without think-

ing of each other as foreigners. We speak the same language, even the same accent; we intermarry; have family reunions and family squabbles, and whatever custom or habit establishes itself in one place is likely to be adopted in the other.

We haven't the same government and we don't want it, for each country has all that it can handle in managing its own affairs. What they would do with some of our Texas and Oklahoma Congressmen in Ottawa or what we should do with some of their French Canadian Deputies in Washington are, thank GOD, problems that do not call for solution. But when the Great Northern Railway needed to be developed there came JAMES J. HILL from Canada, and he did it. When they wanted ideals of life and duty depicted on the walls of the House of Parliament at Winnipeg they came to New York and got AUGUSTUS V. TACK to do it, and there they are, supreme in their loveliness and nobility. Were these things done because HILL was born in Canada and TACK in Pittsburgh? Not for a minute!

They have lots of coal in Canada, but it isn't developed, and they need coal from here. We need lumber and wood pulp and nickel and cobalt and lots of other things from there. We have had general discussions about free trade between the two countries, but they grew rather nasty and somewhat cantankerous, so we learned from that that we are not ready for it in this generation. Let's pass it by. But when it comes to writing a tariff bill it behooves us to bear in mind that we are dealing with our nearest neighbor, and that we have neighborly obligations. If the Great War has not taught us that obligations count in great affairs as well as in personal behavior, then indeed do the poppies bloom in vain on the fields of Flanders.

The Hon. JOSEPH W. FORDNEY is chairman of the Ways and Means Committee of the present House of Representatives and author of the so-called Fordney tariff bill. As it stands it is probably a dead issue; but some kind of a statute must be passed in the next session, and we think it fair to state that the proposed measure is neglectful of our neighborly obligations to Canada. Mr. FORDNEY lives in Saginaw, Mich., and is a considerable owner of timber lands. Over the border, in Canada, other persons own timber lands, and this Canadian lumber reduces Mr. FORDNEY'S profits, which he does not like. We shall not discuss the relation of Canadian lumber to the rest of us; we are not considering our own welfare; we are trying to be sympathetic with Mr. FORDNEY. Canadian lumber is a real trouble to him, just as anything that stands in the way of our own profits is a trouble to us. Now these habitual troubles establish something like grooves in the mind, and we think through them, time and again, often unconsciously.

We do not say this in criticism of Mr. FORDNEY in general. Like the rest of us, he has his faults and his prejudices. But we urge upon Congressmen to bear this disposition of the chairman of the Ways and Means Committee in mind when the tariff bill comes up for discussion again; to remember that Canada is our nearest neighbor and that we have just as many obligations as we have rights and privileges; that we have the same borders, and very much the same kinds of trouble; that we are the same kind of people, and that we cannot strike Canada without hitting ourselves. We need each other.

A Misleading Advertisement

IN THE current number of a leading textile journal we read the following advertisement: "Tell the truth! American chemists and manufacturers are entirely competent to shape their own destiny if afforded proper support and encouragement, without building a Chinese wall around themselves. Why becloud the issues and delude the public with threadbare 'war-talk' and similar bunk? Straight-thinking Americans are not afraid of 'ghosts' no matter from what country they come." Then follows advertising matter as to dyes for sale, and the signature is that of H. A. Metz & Co., Inc.

At the Farbwerke vorm, Meister Lucius und Brüning, at Hoechst, the company Mr. METZ represents can produce dyes at from one-third to one-half the cost of the same dyes made here. Their salaries and wages are one-sixth to one-seventh of those paid in the United States. They have large stocks of dyes and chemicals on hand ready for shipment to the United States against the lifting of the embargo. The Hoechst establishment is part of the Interessen Gemeinschaft, and despite the sore straits of the German Government and people, this great trust and its branch at Hoechst are reputed to be rich; they are reputed to have made vast quantities of high explosives and poison gases for the German army during the war and to have been paid for it. Suppose the "proper support and encouragement" which Brother METZ—for whose immense ability and shrewdness we have profound respect and whom we cannot help liking even though to our minds he is engaged in an effort that, if successful, will utterly destroy the synthetic organic chemical industry in the United States—suppose "encouragement" to the tune of 100 per cent or over 200 per cent duties were levied on German dyes, what would he and his partners do? They know the American dye and chemical markets as well as anybody else alive. Would they not underbid and underbid and get that trade at any cost for at least a year, until American competition was killed? Then wouldn't they and the Badische and Bayer and other people have it right in their own hands?

Brother METZ is an American, born here in New York, and we are willing to admit for his benefit all the loyalty he claims. But how about his friends over in Germany? We don't trust them. While HERMAN would be trying to save American industry, they would overrule him, we are sure; and he does not control the I. G. or even the Farbwerke Hoechst. It is the people back of him that we have reason to fear, and we reason from experience.

Now let's "tell the truth" again. American chemists and business men are not so competent that they can get away with costs of three or two to one against the Germans. American chemists have yet a great deal to learn with only five years' experience against the Germans' fifty. And as for the American manufacturers who are in the business they have still more to learn. In fact, if we only had HERMAN on our side with all his heart and all his interest, instead of representing interests that want to "serve" both German and American industries in that fine German brotherly fashion whereby the advantage and proceeds all go to Germany, we should feel better.

Suppose the Interessen Gemeinschaft gets into the saddle; gets control just as German manufacturers

once had control, then Brother METZ will fight in vain for his American customers. We know those Germans and we do not trust them as he does.

The only way to avoid German control is to do just as England and France and Italy and Japan have done: to put on an embargo and get what we need from Germany under license. That not only saves the industry here and keeps our chemists at work, but gives us also a complete arsenal of defense for chemical warfare in case Germany or any other country should get obstreperous again. And it will cut down our war taxes.

Underdevelopment And Overdevelopment

BEFORE the war when there was an industrial depression the cry always was that the country was "overdeveloped." The development was all right in its way, but it had gone too far and it would require a period of time for people to catch up and require all the facilities that had been provided. Now we have a sort of industrial depression—at least nearly everyone claims there is one—and we do not hear the old familiar cry. Rather everyone is telling everyone that the country needs a great deal of developing, that it is far behind in its "program." Curious, isn't it?

The one thing common to all the times is the disposition to pick out something to blame it on. That is human nature. No one is disposed to indulge in introspection and confess his own faults when found. Some of the claims made as to what is wrong just now will not bear analysis, but it is not customary to analyze things that are said by everybody, although they are usually the things one should be wary of.

The difficulty arises largely from a loose method of thinking, a disposition to regard "development" as something that necessarily proceeds along fixed lines, so that we must be either underdeveloped or overdeveloped or developed just right. Nobody ever admits that things are just right! Obviously, however, development is of various kinds, and styles or demand may change. We may have gone too far in one direction and not far enough in another.

There can scarcely be overproduction of everything that men want, for the average man is willing to spend his income, but there may easily be an excess of capacity for making things that men do not want a great deal, and a lack of capacity to produce things men would like to have once they knew of their existence. It does not follow that because our rate of producing a given thing, whether portable property or fixed property, used to increase at a certain rate, perhaps by a geometrical progression, it should continue to do so until doomsday. Fourteen years and more ago we were building steel freight cars at the rate of 150,000 to 250,000 a year, but it does not follow that we need to build them at that rate throughout the future. A third of a century ago there was a year in which we built 13,000 miles of railroad, but we do not have to do that now. Often in the past the production of coal doubled in less than a decade, and it more than doubled in the 16 years from 1902 to 1918, but we certainly do not have to keep up that particular sort of thing indefinitely.

In 1873 there began the severest industrial depression in the history of the United States. The country was "overdeveloped," of course. Then somebody brought roller skates to the attention of the public, and old timers insist that the building of roller-skating rinks all over the country did much to curtail unemployment. The country was overdeveloped in methods and means to get from one city to another, but underdeveloped in means for skating around a circle. Nowadays there is a vast amount of money being spent in admissions to "movie" shows by people who simply refuse to buy steel beams and channels.

We are going to keep on developing, but not necessarily along the same lines as formerly. We need some new highways to be marked out and as they are marked out men will travel them. A couple of decades hence it will look very simple in the retrospect. We shall not have built 4,000,000 or even 2,000,000 freight cars in the 20 years, or laid 100,000 miles of new railroad or doubled our production of coal or quadrupled the number of skyscrapers or provided one automobile per capita—but we shall have made a great deal of progress, chiefly along new lines, making life more interesting.

The Banker And Research

"OUR industry will spend any amount for lawyers, but almost nothing for chemists." This was the complaint of a very prominent technical man who has striven tirelessly for several years past to "sell" his industry the idea of the importance of fundamental research. He has frequently had the experience that any threatened attack upon that industry, which happens to be one very much in the public eye, will promptly bring any necessary sums for co-operative effort in a legal or economic contest to prevent successful inroads upon the industry's interests. However, just recently one prominent corporation in this industry experienced great difficulty because of unsuspected poisoning of a large number of plant employees. It was obvious to any technical observer that a careful study of the characteristics of the vapors coming from the process would undoubtedly give the cause and probably suggest a remedy for this danger. Nevertheless it proved almost impossible to get the small appropriation needed for this study despite the fact that neglect of the situation promised to result in serious consequences to workmen and damage claims far in excess of the amount needed for the research.

Altogether too many misunderstandings exist between business on the one hand and science and educational institutions training scientists on the other. This misunderstanding is simply the result of radical difference in point of view, a difference for which both parties are about equally to blame. Science has taken too little pains to find out just what industry by and large needs and can use and has all too often taken the stand that results should in themselves be accepted and appreciated at their face value. Neither of these stands can be justified.

On the other hand, industry has been, and still often is, to blame for its unwillingness to use that which is of real value in science. Practically every industry is based upon scientific methods and can advance only as new knowledge can be applied in industrial operations. The last word in business management generally is spoken by the banker. It is a doubly welcome event, therefore, which shows that the banking interests are more and more appreciating chemical science in its fundamentals. It is to be hoped that the science will be increasingly deserving of such appreciation.

Readers' Views and Comments

Boiler Feed Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a letter which appeared in your issue of Oct. 5, 1921, William M. Taylor criticizes an article by the writer on "Boiler Feed Water Purification." In brief he makes the following assertions:

(1) Zeolite softeners do not produce water of zero hardness and by the very nature of the chemical reactions involved are not capable of producing water of zero hardness.

(2) Sodium salts in the raw water in slight amount prevent the complete softening of the water.

(3) The molecular weight of the sodium salts in the zeolite softened water exceeds the molecular weight of the calcium and magnesium salts present in the raw water by about 68 per cent instead of only 5 per cent, which the writer sets forth in his article.

The assertions are not in accordance with the facts for the following reasons:

(1) Any chemist can very quickly and easily prove that a zeolite softener, if properly operated and constructed, will soften water to absolute zero hardness, as defined in the "Standard Methods for the Examination of Water and Sewage."

Mr. Taylor claims to have analyzed the effluent from various zeolite softeners, and found slight amounts of hardness up to about 0.5 grain per gallon, expressed as calcium carbonate. But he does not mention that he examined the conditions under which the said softeners were assumed to be operating, and whether the operation was being cared for properly. The general statement that he did not find a water of "zero hardness," without giving further pertinent details of the operating conditions, does not prove anything. It would be just as logical to claim that an engine or turbine could not possibly meet the manufacturers' guarantee for economy because in some particular test, without checking up operating conditions, it did not do so.

(2) The amount of sodium salts in the raw water has an influence on the *capacity* of the softener—that is, the amount of "zero hardness" water produced—but it does not prevent the production of "zero hardness" water. The softener should be designed properly with a sufficiently greater excess of the zeolite to take care of such conditions. This is in accordance with the law of mass action of most reactions. But Mr. Taylor has exaggerated this inhibitive tendency of sodium salts in the raw water. Zeolite plants have successfully handled waters containing over 1,000 parts per million of sodium chloride.

(3) Regarding the relative molecular weights of the sodium salts in the softened water and the weights of calcium and magnesium salts in the raw water, Mr. Taylor states, "His chemical arithmetic is not accurate," and then proceeds to fall into an inexcusable error. He compares calcium carbonate on one side of the reaction with sodium bicarbonate on the other side. According to Mr. Taylor's comparison a reaction must be assumed analogous to the following formula. Thus:

$$\frac{CaCO_3}{100} + Na_2 \text{ zeolite forms } \frac{2NaHCO_3}{168} + \text{Ca zeolite}$$

A glance at the formula shows that it is not an equation and does not balance. There is an extra CO_2 and H_2O on the right side which are not on the left.

The correct equation is:

$$\frac{Ca(HCO_3)_2}{162} + Na_2 \text{ zeolite} = \frac{2NaHCO_3}{168} + \text{Ca zeolite}$$

Now, 168 is only 6 more than 162, which is $6 \div 162 = 3.7$ per cent excess.

This is less than 5 per cent, which was the figure stated by the writer in the original article, and it is certainly not 68 per cent, which Mr. Taylor claims.

Mr. Taylor mentions that "$CaCO_3$ is held in solution by half-bound CO_2" but then does not apply the idea in the calculation. Hardness is frequently expressed in terms of $CaCO_3$ for convenience, but $CaCO_3$, as such, is relatively insoluble in water, and it is only when the water contains CO_2 that $CaCO_3$ is dissolved in the form of $Ca(HCO_3)_2$. That is how limestone is dissolved and how this form of hardness enters our natural water supplies.

S. B. APPLEBAUM,
Assistant Technical Manager.
The Permutit Co.,
New York, N. Y.

Communications With Russian Scientists

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have read with great interest and appreciation your editorials concerning Russian scientists in general and my professor Ipatieff in particular.

Prof. Ipatieff is a graduate of Michael Artillery School and later of Michael Artillery Academy. Several years before the last war he attained the rank of general in the Russian artillery. He held the chair of professor in organic chemistry in Michael Academy and at the same time delivered lectures in Michael Artillery School and in the University of Petrograd.

So far as I know he continued his work during the period of the revolution and, as I understand it, he even published some of his works in the recent publications of the Russian Academy of Science.

I think that the best way to communicate with him as well as with other Russian scientists is in care of the Russian Academy of Science. Proper address would be as follows, both in English and Russian:

Russia., Petrograd, c/o Academy of Science, Professor Ipatieff.	Россія. Петроградъ. Академія Наукъ. Профессору Ипатьеву.

Mt. Rainier, Md. COLONEL A. I. KRYNITZKY.

A Notable Movement in Metallurgical Education

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have just read with much interest the editorial entitled "A Notable Movement in Metallurgical Education" that appears in the Nov. 6 issue of CHEMICAL & METALLURGICAL ENGINEERING. There is one exception that I have to make and that is in connection with my membership in the New Haven Chapter. New Haven has a very active and creditable chapter in the American Society for Steel Treating, but it is my good fortune to be a resident of Hartford and a member of the Hartford Chapter, which we believe ranks second to none in the Society.

F. P. GILLIGAN,
President, American Society for Steel Treating.
Hartford, Conn.

Italian Chemical Industries

From Our Special Correspondent

GENOA, Italy, Nov. 2, 1921.

STRIKES have occurred in the chemical industries during the past month, owing to the refusal of the workmen to accept the reduced scale of wages arranged for the winter months. The workmen contended that the cost of living had increased owing to the higher foreign exchange. This condition and the fact that the demand for chemicals on the part of consumers and speculators has increased would naturally lead to the expectation that prices would be higher, but such is not the case. The price of a few articles rose, but the great quantities of borax, camphor, ammonium carbonate, calcium chloride, magnesium chloride, cream of tartar, formaldehyde, acetone, caustic soda and the like coming in from Germany kept the price of these chemicals down. This has injured the export business from nations having a higher rate of exchange, such as the United States and Great Britain.

ITALIAN CITRIC ACID INDUSTRY

Because the government fixed the price of citrate of lime at 10,000 lire per ton, the Italian citric acid industry, with works at Palermo, Messina and Vercelli, is having a difficult time, being no longer in a position to produce the acid at a price to compete against tartaric acid, and has been obliged to reduce orders. Besides this, the industry found it difficult to sell citrate of lime at the new price to foreign works producing citric acid. The exportations of this product had risen in 1920 to 8,777 tons, 5,738 tons being destined to the United States, 1,634 tons to England, 746 tons to France and the remainder to Germany and other countries. The exportations during 1919 amounted to only 3,458 tons.

ITALIAN SUGAR PRODUCTION

Owing to favorable weather conditions and to the greater beet-root acreage cultivated, the production of sugar will be greatly increased this year, surpassing 200,000 tons; last year it was only 100,000 tons. The internal consumption, calculated at 220,000 tons, will therefore be nearly covered and the importations will be greatly reduced. These reached 66,160 tons during the first six months of this year. In 1918 there were thirty-four sugar works in Italy and the average yearly production was between 100,000 and 150,000 tons. The importance, therefore, of this year's increase can be realized.

ITALIAN SHALE DISTILLATION

So far very little has been accomplished in Italy in the distillation of bituminous or asphaltic rock to obtain mineral oil for cumbustible purposes. What little has been done has been limited to a single works, the Società Italiana Asfalti, Bitumi, Catrami e Derivati, which has constructed a plant for producing 15,000 tons of mineral oil per annum. After the success of this concern was assured, a number of Italian economists started a campaign to utilize the great abundance of asphaltic rock and lignite throughout continental Italy. It has been sought to interest the government in a plan for the protection of the new industry, but little is expected from this quarter, owing to the fact that the government is already occupied with enough to keep it busy for some time. Neither is much to be expected from Italian capitalists, because of their present financial difficulties. It has been suggested that this would be a field worthy the attention of American financiers, taking advantage of the present low value of the Italian lire. It is contended that whereas now the shale deposits are powdered and exported for road-making purposes, they could with comparatively little expense be distilled in Italy. In 1920 Italy imported 182,004 tons of mineral oil, valued at 235,000,000 lire, most of which came from the United States, Mexico, Great Britain and France.

HYDRO-ELECTRIC DEVELOPMENTS

The electric substation of Predare started operation during October. This is the first of a group of hydro-electric power substations to be constructed by the Società dell'Ozola in the Reggio Appenines, and is also the first to distribute on a very large scale electric energy between different Italian regions. For the present it will transmit electric energy of the Società Adamello toward the Tuscan region, but later it will also include a hydro-electric power-generating station. The lines of the Società Adamello are already connected with those of the Società Edison, Società Conti and others, and will be connected during the next few months with the lines of the Società Adriatica, and later with plants in Piedmont. In this way will be formed a large inter-regional distribution of the electric energy produced in the power stations of the Nerina, Adamello and Aosta Valleys to points in all portions of northern and central Italy.

ITALIAN IMPORTS AND EXPORTS

The financial difficulties suffered in Italy by all classes and which were rendered more serious by the heavy taxes reduced all importations during the first six months of this year, as can be seen from the following figures:

	Jan.-June, 1921 Tons	Jan.-June, 1920 Tons
Chemicals	60,500	133,041
Acids	7,049	14,143
Paints and varnishes	3,942	6,454
Wood pulp	19,530	37,329
Malt	1,436	869
Petroleum	32,798	65,636
Cottonseed oil	11,254	9,288
Metallic minerals	15,099	15,052
Cast iron and steel scrap	20,832	90,290
Pig iron, cast iron and steel ingots	35,678	96,028
Iron and steel (sheets, bars, wire)	107,121	126,048
Galvanized and lead covered steel and iron plates	10,338	22,163
Copper, brass and bronze	10,630	7,575

Despite the efforts of Italian producers to increase their exports, success could be attained in only some cases. This is demonstrated by the following export statistics, which are those available for the first six months of the present year:

	Jan.-June, 1921 Tons	Jan.-June, 1920 Tons
Chemicals	43,327	28,454
Acids	5,188	5,515
Paints and varnishes	1,521	1,204
Wood pulp	653	None
Metallic minerals	7,082	8,184

Heavy importations of war reparation coal permitted an increase of exportations of coal from this country, that reached 102,802 tons in the first six months of this year, against 36,582 in the corresponding months of last year. The importations of coal were reduced to 2,346,914 tons during the six months, against 2,594,612 in the corresponding months last year.

The Manufacture of Naval Stores From the Dead Wood of the Southern Pines

Recent Industrial Development of the Process for the Extraction of Turpentine, Rosin and Pine Oil From Stumps and Other Dead Wood of Cut-Over Pine Lands—Solvent Treatment and Recovery—Chemical and Physical Properties of Products

BY C. M. SHERWOOD
Naval Stores Division, Hercules Powder Co.

THE extraction of rosin, pine oil and turpentine from dead pine wood is a comparatively recent process. The first plant was erected at Gulfport in 1909 by the Yaryan Naval Stores Co. and had a capacity of about 90 tons of wood per day; in 1911 this was increased to 175 tons. In 1912 the same company built an additional plant of a much greater capacity at Brunswick, Ga. Since that time several other installations have been made until at present there is a total of eight plants, ranging in capacity from 20 to 550 tons of wood per day.

In May, 1921, the Hercules Powder Co. assumed control of the Yaryan Rosin & Turpentine Co., a reorganization of the older company, and also about that time completed a plant at Hattiesburg, Miss. The combined maximum capacity of these plants is approximately 1,000 tons of wood per day, making this company the largest producer of naval stores by the extraction process in the world.

Up to the present time it cannot be said that this industry has been profitable. The Yaryan company was in receivers' hands during a large part of its existence and it would probable have been a total loss to the original investors but for a short period of abnormally high prices due to the war. Plants cannot be operated profitably at prices which have prevailed in 1921. The development of the industry will require very large capital expenditures, certainly without immediate return, and with little chance of a fair ultimate return unless the investment in physical properties is followed by chemical research on a scale that few organizations are equipped to undertake.

The wood is obtained from cut-over land, and is chiefly the Southern long-leaf pine (*Pinus palustris*). This dead wood may be divided into two general classes —namely, stump and top wood. The stump wood is richer in extractable products and is correspondingly more valuable. Top wood is the upper part of the dead tree. It is a curious fact that the section of the tree from about 10 ft. above the ground to the first limbs is generally very poor and is culled, while above the first branches the rosin and oils are found in both the branches and body of the tree in considerable amounts. It seems to be generally true that the twisted grain wood is richer than the straight grain. This is explained, in a rather unscientific way it is true, on the ground that the oils and rosins passing through the interior of the tree are held back by the bends and gradually accumulate there. At any rate, whenever there are any twists and knots one finds extractable products in large amounts.

FIG. 1. BORING STUMPS JUST PREVIOUS TO BLASTING OUT WITH DYNAMITE

FIG. 2. PILED WOOD READY TO BE HAULED TO THE PLANT

The distribution in the roots is also interesting. The *Pinus palustris* has two types of roots, lateral and tap. The lateral roots are close to the surface of the ground and are very rich in rosin, turpentine and pine oil; the tap root, each tree usually having but one, goes straight down into the ground. It is soft and spongy and contains practically no valuable products—in fact it is almost worthless even as fuel. It is the general belief that the tree obtains most of its moisture from this source.

In wood operations the top wood is simply cut into 4-ft. lengths and split if too large in diameter for milling. Stumps are generally blown out with dynamite. The pieces are hauled by wagons to a tram line or railroad and loaded into box or rack cars on which the wood is transported directly to the plant.

FIG. 3. RESERVE OF WOOD SUPPLY AT BRUNSWICK PLANT, SHOWING STACKS OF THE POWER HOUSE IN THE DISTANCE

In order for wood to be suitable for use it should age for several years; top wood requiring at least 5 years and stump wood 2 or 3 years longer. "Green" or insufficiently aged wood has been tried from time to time, but the difficulty experienced in milling is so great that its use is impractical. Furthermore, the yields are not so great as with the well-seasoned material.

Good land yields 8 to 15 tons of wood per acre, depending on the section of the country. Therefore a plant having 500 tons per day capacity would receive daily the wood from about 50 acres of land. From these figures one can obtain some idea as to the magnitude of the wood operations and of the benefits Southern agriculture will derive from this wholesale removal of stumps.

Preliminary Processes of Grinding and Steaming

In all the plants under the control of the Hercules Powder Co. the steam-solvent or extraction process is used. The wood is unloaded from the cars onto a conveyor which takes it to a hog or chipper, where it is cut into pieces about 2 in. long and ½ to 1 in. thick. The hogged wood then passes directly into a hammer mill of the Jeffrey or Williams type, where the millling is completed, the wood being reduced to sizes varying from dust to pieces which will not pass through a 4-mesh screen. This milled wood is carried by belt conveyers to upright cylindrical steel tanks called extractors. These extractors vary in size at different plants but generally hold from 7 to 14 tons of wood. Charging is accomplished by means of doors at the top. A perforated plate about 3 ft. above the bottom of the extractor serves to hold up the chips. Each extractor is equipped so as to permit the use of both coils and live steam. A bottom outlet permits the solution to be "dropped" as desired.

After the extractor is filled, the first operation is to steam for turpentine and pine oil. Live steam is used on account of the high boiling point of these compounds. Each extractor is steamed for 3 or 4 hours, depending on the amount and temperature of the steam used. During this operation practically all the turpentine and about half the pine oil are distilled off, the distillate being condensed and run to a separator, where the pine oil and turpentine, being immiscible with water, are decanted off the top. This solution of "crude turpentine" has a specific gravity of about 0.880 at 15.5 deg. C. and consists of approximately 70 per cent of turpentine and 30 per cent of pine oil. It is fractioned into commercial turpentine and pine oil by repeated distillation in ordinary pot stills. During this distillation it is necessary to use live steam, as the high temperature needed for direct distillation had a tendency to break down both compounds, causing them to darken and giving unpleasant, empyreumatic odors.

Treatment With Solvent

The steamed wood still contains the rosin. To remove this and whatever oils are left in the wood it is boiled with a solvent. At present gasoline is commonly used, although coal-tar products, such as benzene and toluene, have been tried to a limited extent. The great difficulty with the latter class of solvents is that they not only take out the rosin but also dissolve a large quantity of oxidized rosin, pitch and coloring matter, which renders the resulting rosin so dark that it is unfit for nearly all uses. It is evident, therefore, that the petroleum distillate has a sort of selective solubility, leaving the dark products behind in the wood and extracting only the lighter colored resinous matter.

The solvent treatment is a countercurrent proposition in which the fresh solvent comes in contact with the most exhausted chips. This solvent then goes to the chips containing a little more rosin until finally the solution is run onto wood which has been steamed for turpentine only and from which no rosin has been extracted. The resulting solution is then dropped through the bottom outlet of the extractor to the settling tank, where chips, dirt, etc., settle out.

By this process the wood is in contact with the solvent for 4 or 5 hours. The final solution usually contains about 15 per cent of rosin, although of course many factors, such as the volume of gasoline used, the percentage of rosin in the original wood and the completeness of extraction, may cause this percentage to vary greatly. It is advisable to have this solution as strong as possible so as to prevent the handling of large volumes of weak liquor.

From the settling tank the solution is pumped to evaporators. These evaporators are generally ordinary still pots equipped with steam coils and sparge pipes. During the first part of the distillation the solvent distills off and is run back to a storage tank, from which it is used again for extraction. The other frac-

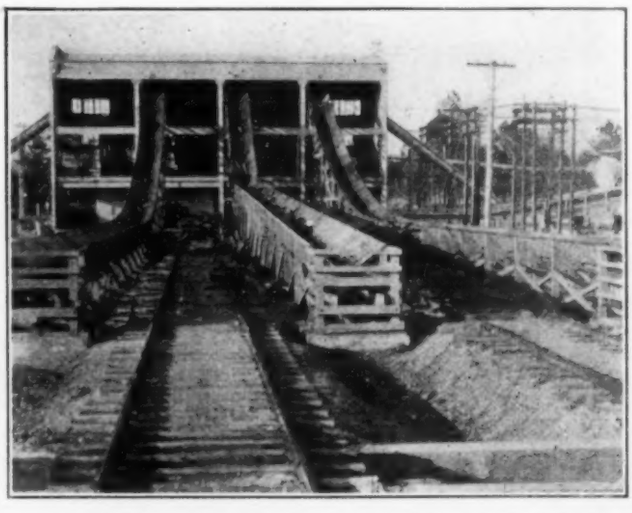
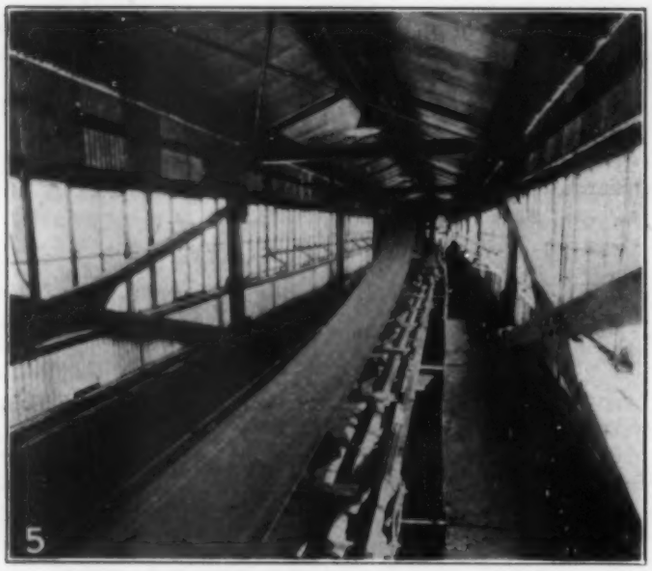
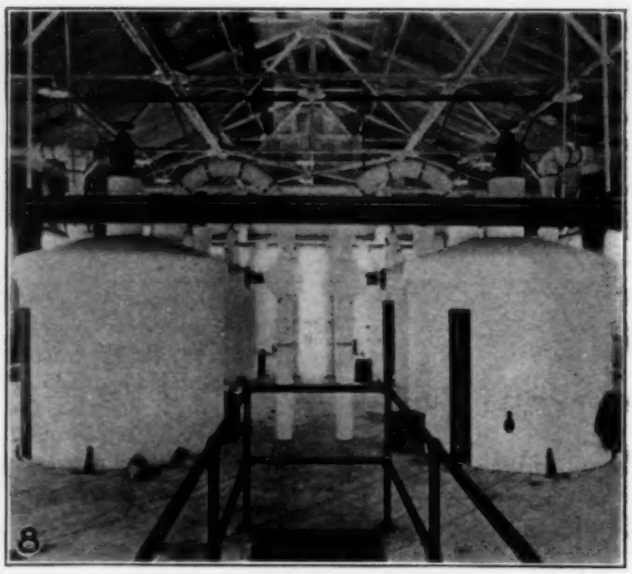
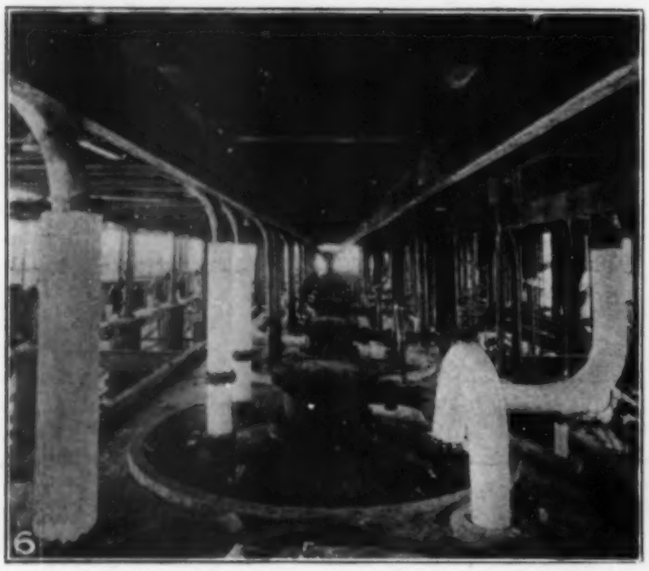
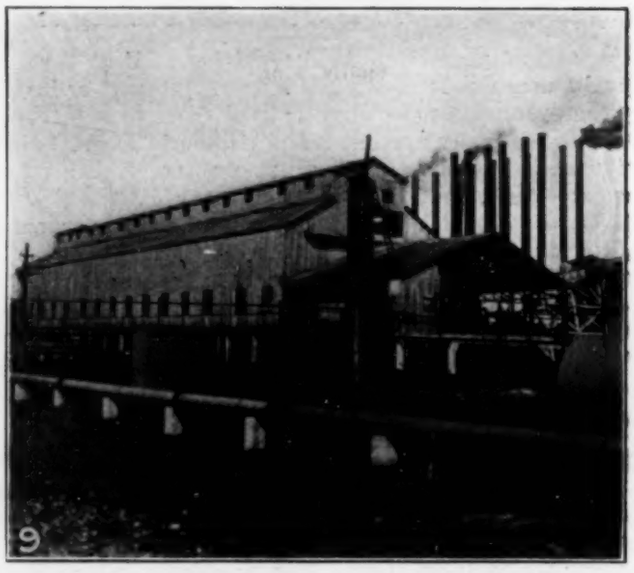


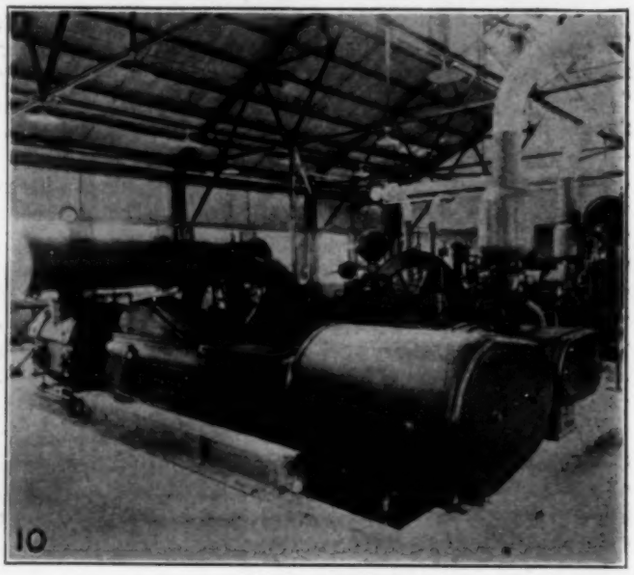
FIG. 4. CONVEYOR SYSTEM AT HATTIESBURG PLANT, WITH MILL ROOM IN THE BACKGROUND











FIGS. 5 TO 10

Fig. 5. Belt conveyors used for carrying milled wood to the extractors, Hattiesburg plant.

Fig. 6. Interior of extractor building, Hattiesburg plant.

Fig. 7. Refinery building, Hattiesburg plant, with extractor building in the background.

Fig. 8. Interior refinery building, showing rosin stills, Hattiesburg plant.

Fig. 9. Extractor building, Brunswick plant.

Fig. 10. Air compressors at the Hattiesburg plant.

tions are high boiling and consist of mixtures of solvent and pine oil. They are redistilled to yield more solvent and an inferior grade of pine oil. The rosin remains behind in the still as a residue and is run out and poured into wooden barrels holding about 50 gal. With this type of apparatus one must use an intermittent or batch process.

In some of the plants of the Hercules Powder Co. Yaryan evaporators are used instead of pot stills. With this equipment a continuous two-stage operation is carried on, the majority of the solvent being taken off in an evaporator operating at about 50 lb. steam pressure and 20 in. vacuum, while the higher boiling liquids are evaporated at about 100 lb. steam pressure and 25 in. vacuum. The rosin is continually pumped out of the bottom outlet of the evaporator to vats, from which it is barreled as described above.

Recovery of Solvent

After the extraction of the wood is completed, the spent chips contain about 40 per cent of their weight of solvent. This is removed by injecting live steam into the chips in a manner similar to that used in the turpentine extraction. Usually 4 or 5 hours' steaming is needed to drive off the solvent, the great difficulty being to remove the last traces. Even after this steaming there is still considerable solvent in the wood.

Analysis of samples immediately after steaming

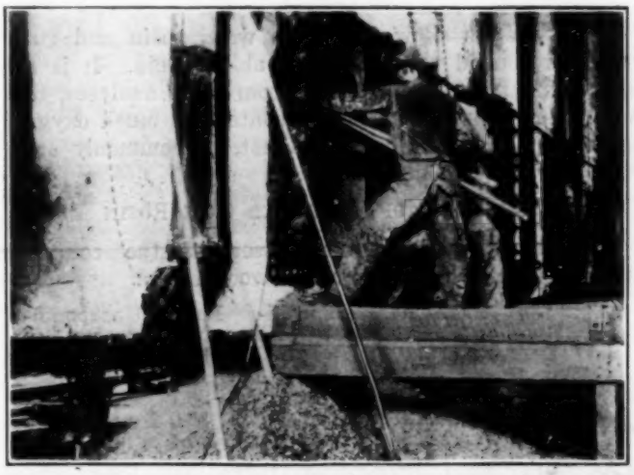


FIG. 11. "PULLING" AN EXTRACTOR. THE SPENT WOOD GOES DOWN THROUH THE FLOOR TO A MOVABLE BELT CONVEYOR WHICH TRANSPORTS IT TO THE FUEL BIN

have shown as high as 10 gal. of solvent per ton of spent wood, although the average is much less than that, being probably 2 or 3 gal. per ton. The accurate determination is very difficult due to the fact that when the hot chips are withdrawn from the extractor the solvent evaporates very rapidly. The loss of solvent at this point is probably the chief single source of loss in all the operation, and much valuable work can undoubtedly be done to improve this condition.

The spent wood is then "pulled" through the front door in the side of the extractor and falls to a conveyor, which carries it to the fuel bin, from which it is transported to the power house as needed. Under normal conditions the spent wood is about sufficient to give all the fuel necessary for the operation of the plant.

It may be seen from the above description that the whole operation is by no means simple. Provision must be made for an adequate supply of wood at all times. To do this it is necessary to have a wood force double that required to operate the plant. On account of the frequent rains which slow down the wood operations for weeks at a time, the plant should always have a large supply of reserve wood on hand. The same may be said of solvent. Under normal conditions about 8 to 10 gal. of solvent is lost per ton of wood worked. This means that several thousand gallons must always be in reserve. In addition it may be roughly estimated that 200 gal. of solvent is required for every ton of wood worked—that is, for a hundred ton plant 20,000 gal. must be kept in the system. As both the solvent and manufactured products are very flammable, great care must be taken to prevent fires.

Steam-Distilled Wood Turpentine

The products obtained from this process are, as mentioned before, turpentine, pine oil and rosin. The turpentine is sold on the market as steam-distilled wood turpentine to distinguish it from the spirits of turpentine or gum turpentine, which is made from the gum of the living tree. and from destructive turpentine, which is made by the destructive distillation of dead pine wood. Formerly wood turpentine was looked upon with disfavor by the paint and varnish trade, but since the product meets the highest specifications required commercially, this prejudice has been almost entirely overcome.

One of the great advantages of the better grades of wood turpentine is its uniformity. This is especially true of the output from well-equipped plants where a careful chemical control is maintained. In the Hercules plant the present Navy specifications are used as a standard which the turpentine must meet. A typical analysis of this product is as follows:

Initial boiling point	154 deg. C.
Per cent boiling below 170 deg. C	90.5
Polymerization residue	1.0
Specific gravity at $\frac{15.5 \text{ deg. C.}}{15.5 \text{ deg. C.}}$	0.865
Color	W.W.
Flash point (Abel closed cup)	34 deg. C.
Refractive index at 15.5 deg. C	1.469

A comparison of wood and gum turpentine is not particularly easy on account of the variation in both products. If, however, the above analysis is taken as typical of wood turpentine, one can say that the refractive index and specific gravity are in most cases higher in gum than in wood turpentine. Furthermore, gum turpentine, especially when freshly distilled, has a fragrant, sweet odor, absent from wood turpentine. This is supposed to be caused by certain esters and aldehydes present in the gum. Turpentine loses much of this fragrant odor on standing. Wood turpentine, due to the fact that it is always redistilled, generally has a better color than gum turpentine, which is barreled directly from the still without redistillation.

Pine Oil and Its Characteristics

Pine oil is perhaps the most interesting of all the products. While in the gum industry no pine oil is obtained, yet in this process about 1 part of pine oil to 2 parts of turpentine is recovered.

This pine oil when first produced was considered practically worthless. In later years, however, it has become valuable in many ways. In the flotation field it is one of the best frothing oils known and great quantities are used yearly for this purpose. It is the basis of a variety of medicinal and disinfectant solutions. The rubber industry consumes quantities for various purposes. The paint and varnish industry has also made use of the

peculiar properties of pine oil. Toch[1] makes the following comments on the application of pine oil: "It has been used to a considerable extent for making paints which should dry without a gloss, and as a "flatting" material it has been successful. It has the excellent quality of flowing out well under the brush and of not showing brush marks, the latter because it evaporates so very slowly. It is a very powerful solvent, and many of the acid resins which have a tendency to separate when they are insufficiently cooled with drying oil will remain together when pine oil is added."

A high-grade commercial pine oil manufactured at Brunswick, Ga., had the following analysis:

Boiling range	180 deg. C.-225 deg. C.
Specific gravity at 15.5 deg. C.	0.935
Color	Light straw
Refractive index at 15.5 deg. C.	1.479
Polymerization residue	3 per cent

Composition of Pine Oil

The composition of pine oil is rather uncertain. It was at first thought to be a hydrocarbon similar to pinene, but later Teeple[2] and Toch[1] showed that the pine oil was very similar to terpineol, $C_{10}H_{17}OH$.

Toch found that a pine oil of 0.942 gravity contained 78.1 per cent C, 11.5 per cent H and 10.4 per cent O, while the theoretical for terpineol is 77.68 per cent C, 11.77 per cent H and 10.38 per cent O. A sample of pine oil, analyzed at our experimental station, having a gravity of 0.933 and a boiling range of 180 deg. C. to 225 deg. C., showed 80.7 per cent C, 10.9 per cent H and 8.4 per cent O. It is probable that some hydrocarbons were present. In fact the commercial pine oil undoubtedly consists of several distinct compounds.

The origin of pine oil is still a mystery. Dr. Toch believes it is due to hydrolysis and oxidation as a result of exposure to the atmosphere. We are inclined to the belief that pine oil is present in the living tree as an essential oil, and is not a product of hydrolysis or oxidation. It is our intention to study this interesting problem very shortly.

[1] *J. Ind. Eng. Chem.*, vol. 6, No. 9, p. 722.
[2] *J. Am. Chem. Soc.*, vol. 30, p. 412.

FIG. 12. DIPPING ROSIN FROM VATS INTO BARRELS. THIS IS THE GENERAL PROCESS USED IN BOTH GUM- AND WOOD-ROSIN INDUSTRIES

Rosin is the chief product extracted, since approximately a standard barrel of rosin (280 lb. gross) is recovered from 1 ton of wood. As usually obtained it is a ruby red product. The red color is peculiar to this grade of rosin, and many theories have been advanced as to its origin. We believe that the greater part of this red color has its origin in forest fires, with a resulting decomposition and oxidation of the wood and rosin. This theory is based on the following experiments:

If one removes the outer portion of a stump, extracts the inner part with gasoline and evaporates the solvent, the rosin obtained will have only a small amount of red coloration. If, however, the wood is charred and then extracted, it will give a rosin with the characteristic dark red color. Rosin extracted from the living tree will also show comparatively little of this red color, but it is not a lighter grade of rosin than that taken from the interior of a stump.

Rosin is considered to consist principally of abietic acid, the formula of which is generally given as $C_{20}H_{30}O_2$. Several ultimate analysis were made at our experimental station in order to learn how closely wood and gum rosins correspond to the above formula. These gave the following percentages:

Product Analyzed	C	H	O
Gum F	77.41	9.56	13.03
Gum W.W.	78.78	10.38	10.84
Wood rosin (Yaryan F)	78.12	9.90	11.98
Abietic acid (prepared in lab.)	79.34	10.18	10.48
Abietic acid (calculated $C_{20}H_{30}O_2$)	79.41	10.01	10.58

These results show that both wood rosin and gum rosin correspond very closely to abietic acid. It is an interesting fact that, judging from these analyses, the wood rosin does not appear to contain as much oxygen as ordinary gum rosin and is not, as commonly supposed, a highly oxidized rosin.

Comparison of Wood and Gum Rosin

The following is a comparison of the common analytical constants of gum and wood rosin:

Rosin	Acid No.	Saponification No.	Ester No.	Unsaponifiable, Per Cent
Yaryan F.	147.7	162.7	15	7.3
Gum F.	155.9	174	18	4.8
Gum W.W.	154.7	182.8	28.1	5.1
Gum F.	162.4	176.4	12.0	5.2
Yaryan F.	150.5	170.9	20.4	6.0

As with wood turpentine, there has been some prejudice against wood rosin among users. Probably this objection has been justified in the past, as the earlier products in many cases were very inferior. By reviewing the process one can see that there is a possibility by careless operation both of contaminating the rosin with solvent, which will obviously soften it, and of unduly darkening the rosin by overheating. Both of these faults were of common occurrence during the pioneer work. With careful operation, however, one can be assured of a very uniform product, particularly free from foreign matter. While the color prevents its use for some purposes, yet under most other conditions it doubtless has an advantage over gum rosin because of its uniformity and cleanliness.

At present the production of naval stores from this source is only about 10 per cent of the total output, and is consequently of comparatively minor importance. However, with the growing shortage of living trees and the consequent diminution of the supply of gum product, this industry in the future will play an important part in the production of naval stores.

Brunswick, Ga.

Importance of the Olefine Gases and Their Derivatives III—Ethylene Dichloride*

A Commercially New Extraction Agent Prepared From Ethylene and Liquid Chlorine, Having Properties Approaching Those of an "Ideal" Solvent—Chemical Stability—Sharp Boiling Range—Low Fire Hazard—Physiological Properties

BY GEORGE O. CURME, JR.

WHILE ethylene dichloride stands as one of the earliest organic chemical compounds isolated and described, its application in the chemical industry to the purposes for which it seems by nature so well fitted has never reached proportions to make its name known among a majority of the industrialists. Why this should be is one of the unexplained mysteries of chemical technology; for, while this material has remained unrecognized technically, at the same time a wide search has been made by chemists for a substance of almost its identical properties to amplify the very restricted number of commercial solvents now at the command of our extraction industries. It was through the first synthesis of this substance from ethylene and chlorine by four Dutch chemists[1] that the name of "olefines" (oil-forming) was given to the entire series of homologous ethylene hydrocarbons. This name has lived, but the material itself has been pushed to the back shelves of our chemical museums, where it has been apparently overlooked in this search. It may be that a lack of knowledge of convenient technical processes for its production has caused this neglect. In any event, that this material is now on the market as a product of the rising olefine gas industry is an item which should interest many industrial chemists, seeking for new possibilities with new commercial materials.

Since the first production of ethylene dichloride in 1795, it has frequently been the subject of academic investigations. Its properties have been accurately catalogued, its sources of production have been described, and through the limited number of reactions which it has been shown to undergo its chemical stability has been demonstrated. This compound ($C_2H_4Cl_2$) has been variously known as "Dutch liquid," "elaylchloride," "ethylene chloride," "ethylene dichloride" and also by the more exact term "1,2-dichlorethane." Of these names, ethylene dichloride is perhaps the most used and is most descriptive of its method of preparation. When pure, it is a colorless liquid, with a pleasant, chloroform-like odor. It boils at 83.5 deg. C. at 760 mm. and on cooling to a low temperature forms crystals which melt at —36 deg. C. It has the density, $D^{\frac{20}{4}} = 1.2569$; the specific heat of 0.3054 at 30 deg. C.; and the latent heat of vaporization of 157.5 B.t.u. per lb. at 0 deg. C.

Of the various methods of preparation of ethylene dichloride the only one of commercial importance is the direct combination of ethylene and chlorine. This reaction takes place readily under a variety of conditions, and different combinations of these conditions have formed the basis of recent patents,[2] which, however, do not seem to have been operated successfully to date. In the earlier described processes gaseous ethylene and chlorine were simply permitted to mix in a vessel, the liquid product condensing out as formed. In this procedure, however, the rather considerable heat of reaction caused the reacting gases to assume a temperature much above normal with an attendant continuation of the reaction to form higher chlorinated products, such as trichlorethane. Then, too, this reaction is slow and requires a large reacting volume for a given production. Modifications of this reaction have been suggested, such as to cool the reacting gases and to use catalysts such as moisture[3] or calcium chloride.[4]

Brooks and Smith[5] have suggested the use of chlorine dissolved in a solvent for the production of mixed ethylene and propylene dichlorides from oil gas and also the use of sulphuryl chloride as a chlorinating agent for unsaturated hydrocarbons from oil gas. In the writer's work it has been found that when dry ethylene and liquid chlorine are brought into contact with each other there is a rapid and exceedingly smooth formation of ethylene dichloride.[6] This reaction is carried on preferably at temperatures somewhat below 0 deg. C. and at a pressure corresponding to the vapor pressure of chlorine. There is very little further chlorination of the ethylene dichloride, even though held for some time in an excess of liquid chlorine—an excellent example of the stability of this substance. As a byproduct, ethylene dichloride has been found in the production of other materials also produced by the chlorination of ethylene—e.g., ethylene chlorhydrin and mustard gas (β,β'-dichlorethyl sulphide). Also it has been described as occurring in the mixture found in the manufacture of carbon tetrachloride from carbon disulphide, and also from the chlorination of natural gas. A limited quantity of ethylene dichloride has been offered on the market within the past few years, but from just what source it is not known to the writer.

Investigations in the past have shown that chemical derivatives of ethylene dichloride can be made. Regnault described the production of vinyl chloride by action of alcoholic potash on this material.[7] Matter,[8]

A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh.

*This article, the third of a series of five, treats of the technical significance of a well known laboratory substance which is now made available commercially through the development work carried out by the Carbide & Carbon Chemicals Corporation at Clendenin, W. Va. Parts I and II were published Nov. 16, p. 907, and Nov. 23, p. 955, respectively.

[1]Deimann, Troostwyk, Bondt and Louwrenburgh, *Crell's Ann.*, vol. 2, pp. 195, 310 and 430, (1795).

[2]Mercereau, U. S. Pat. 1,224,485. Brooks and Smith, U. S. Pats. 1,231,123 and 1,235,283. Tinker, Br. Pat. 108,062. Harding, Br. Pat. 126,511.

[3]Brooks and Humphrey, *J. Eng. Ind. Chem.*, vol. 9, p. 750 (1917).

[4]Smythe, *J. Soc. Chem. Ind.*, vol. 35, p. 1,130 (1916).

[5]Brooks and Smith, U. S. Pat., *loc. cit.*

[6]G. O. Curme, U. S. Pats. 1,315,542 (1912) and 1,315,545 (1919).

[7]Regnault, *Ann.*, vol. 14, p. 30 (1835).

[8]Matter, U. S. Pat. 1,237,076 (1917).

Hough,[9] Brooks[10] and Hilbert[11] have shown that glycol can be made by hydrolysis with an alkali or alkali salt at elevated temperatures. Boehringer[12] describes the formation of ethylene diamine with liquid ammonia and at high temperatures. However, these extreme conditions necessary to bring about reaction in the above instances, as well as the method of production mentioned above, show clearly that it is among the most stable of the simpler organic compounds.

Solvent Properties

This characteristic of ethylene dichloride, in addition to its high solvent action on oils, fats, waxes and certain resins and gums, points clearly to its qualifications as a solvent. The solubility of these materials in the chlorinated solvents as a class is already too well known to need detailed description and for general purposes ethylene dichloride ranks among the best. Dr. L. H. Baekeland,[13] in his Chandler Foundation lecture in 1914, speaks very highly of the value of this material as the chlorinated solvent of the future.

Resistance to Hydrolysis

In a comparison with other chlorinated solvents, the outstanding characteristic of ethylene dichloride is its chemical stability above mentioned and its resistance to hydrolysis under conditions of solution and extraction. The hydrolysis of carbon tetrachloride to break off hydrochloric acid in extraction work where water is present is well known, and has unfortunately resulted in serious damage to iron- and lead-lined extraction equipment. The commercial chlorinated solvents derived from acetylene—namely, acetylene tetrachloride, trichlorethylene and dichlorethylene—which must not be confused with the above, are also subject to the same objection, though to a lesser degree. Ethylene dichloride, alone of all the chlorinated solvents, may be safely handled in presence of water at a boiling temperature, in iron or other metal vessels without danger of damage from corrosion. In confirmation of this freedom from destructive effect, tests on corrosion by organic halides published by Doughty[14] show ethylene dichloride as the only one of the commercial chlorinated solvents examined which did not reveal corrosive action under the condition of the tests made.

The relatively lower density of this solvent is favorable to its use, as the cost per volume of liquid used is thus lessened. The boiling point of 83.5 deg. C. is ideal for most purposes, permitting a complete removal of the solvent without excessive temperatures, and yet permitting easy condensation and giving minimum loss on handling. As a commercial product it can be supplied in high purity; therefore instead of boiling range of many degrees it will boil sharply at a given temperature. This feature avoids one of the main objections of most commercial solvents—namely, that of leaving a "heavy end" in the extract as well as in the residue.

Again the stability of ethylene dichloride is shown in its resistance to oxidation. Many of the chlorides of carbon when kept in a partly filled container split off hydrochloric acid and give an oxidized product; for instance, in the cases of chloroform and carbon tetrachloride the poisonous phosgene is formed under such conditions. With ethylene dichloride this oxidation does not occur to a noticeable extent; accordingly no preservative is needed, it may be re-used indefinitely, and no unpleasant odor or flavor is given to edible products.

The above characteristics recommend this solvent particularly for the extraction of edible oils and other products where highest purity is a prime requisite. A further application in the extraction of grease from wool seems to offer promise as well.

In quite another line of solvent work where it is desirable to use a strongly reactive substance in solution, the stability of ethylene dichloride is of advantage. In such reactions where free chlorine, sulphuryl chloride, sulphur monochloride and other active reagents are to be used in solution, ethylene dichloride may safely be used as a solvent without being affected.

Low Fire Hazard

It has been found that ethylene dichloride will support combustion when ignited in the air, but only with difficulty. It is a compound just on the border line of the fire-extinguishing chlorinated hydrocarbons and the combustible hydrocarbons. In many cases when ignited the draft from the combustion will blow out the flame, so weak is the tendency to burn. In any case, as regards industrial use, being heavier than water, it is therefore extinguished by water in contradistinction to benzene or gasoline.

Physiological Properties

The effect of inhaling the vapor of ethylene dichloride is not dangerous, although, as in the case of any organic solvent, it is to be avoided as far as possible in high concentrations and for extended periods. In earlier days of medicine this substance was in actual use as an anæsthetic,[15] which of itself demonstrates that there need be no serious after-effects from its inhalation, even though carried to the extreme point of loss of consciousness.

It is interesting to note that in current articles on matters relating to the solvent extraction and related industries the matter of the solvent is given great importance. In particular, the need of an "ideal" solvent is emphasized. The writer is quite willing to admit that such perfection is not to be hoped for in any material of chemistry; but as a solvent that approaches the ideal, it is quite possible that it will be found that this has been contributed by the olefine gas industry in ethylene dichloride.

Summary

The characteristics of ethylene dichloride which recommend it for use in extraction and solvent work are:

1. It is an excellent solvent for oils, fats and greases.
2. It is a pure chemical with constant boiling point.
3. It can be removed completely from both extracts and residue, leaving no unpleasant odor or taste.
4. Its density and heat of vaporization are low.
5. Its stability permits indefinite re-use and freedom from chemical action on materials treated.
6. It does not corrode metal, even in presence of water at the boiling point.
7. It may be used without danger to workmen.
8. It presents a very low fire hazard.

(Part IV, dealing with isopropyl alcohol, will be published in a subsequent issue.)

[9]Hough, U. S. Pat. 1,206,222 (1915).
[10]Brooks and Humphrey, U. S. Pat. 1,215,903.
[11]Hilbert, U. S. Pat. 1,270,759 (1918).
[12]Boehringer, Ger. Pat. 218,466.
[13]Baekeland, *J. Ind. Eng. Chem.*, vol. 6, p. 774 (1914).
[14]Doughty, *J. Am. Chem Soc.*, vol. 39, p. 2685 (1917).

[15]Gwathmey, ("Anesthesia," Appleton, New York, 1914, p. 749) states: "Its [ethylene dichloride] anæsthetic action was first studied by Simpson in 1846, Snow in 1848, Clover in 1848 and Richardson in 1851. The latter regarded it as a good anæsthetic, very much like chloroform in its action, although less rapid."

On the Theory of the Hardening of Metals

The Japanese Scientist Thinks That Hardness in Metals Is Due in Part to Forces Between Atoms and in Part to an Interlocked, Strained Crystalline Structure—Heat-Treatment of Duralumin Is Quite Similar to That of Steel

BY KOTARO HONDA
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IN this journal for June 15, 1921, vol. 24, p. 1057, Zay Jeffries and R. S. Archer have written an interesting article entitled "The Slip Interference Theory of the Hardening of Metals," explaining by their theory many complicated phenomena regarding the hardening of steel by quenching, as well as the aging of duralumin after quenching. The essential feature of the theory lies in the assumption that the internal slip in the metal caused by stress is hindered by the presence of fine, hard particles scattered uniformly throughout the mass, and hence the metal is greatly hardened. However, this assumption is not very probable, when the quantity of hard particles amounts only to a few per cent of the whole mass.

To take a simple analogy, do we know how much gelatin becomes hardened when mixed with a few per cent of fine sand or fine grains of some compound? On the other hand, where hard particles contain only a few per cent of gelatin or other cementing material, the whole mass becomes considerably hard. In a solid solution, the solute is distributed, in particles no larger than an atom, among the atoms of the solvent according to the space-lattice of the latter, and hence the analogy between a metal containing hard particles of much larger size and the solid solution can no longer hold, as the conception denoted by the word "hard" is not applicable to the atoms themselves. Hence the slip interference theory should not be extended to the case of solid solution.

Intermolecular Forces

In a solid substance, the molecular force exerted in an atom from one of its neighbors consists of an attraction and a repulsion; if it were mere attraction, all the atoms will collapse into a single compact mass. Thus the expression of the molecular force between two atoms will be given by an expression, for example, of the form

$$F = \frac{am}{r^{\mu}} - \frac{bm}{r^{\mu+\nu}}$$

where m is the mass of the atoms, r is the average distance apart, a and b are both positive constants characteristic of the substance, μ and ν are positive values probably greater than 3. Since atoms have a complex structure, it is easy to understand that μ and ν are not constant for wide variations in the separating distance and especially when the atoms are placed close together, their values depending on the distance and orientation of the atoms. At a very small distance the second term measuring repulsion predominates, while at a relatively large distance the first or "attraction term" prevails. When no external force acts on the substance, the resultant force acting on any one of the atoms is zero.

A hard substance may therefore be defined as one for which a small variation of the relative configuration of the atoms causes large forces between atoms; that is, $\frac{dF}{dr}$, or a, b, μ and ν are large. It is also evident from this consideration that the hardness or strength of a substance changes when it undergoes an allotropic transformation. To take a concrete example, martensite, which may be considered as an allotropic modification of austenite, has a great hardness as compared to the latter. According to the result of X-ray analysis, the atomic distribution of austenite is as a face-centered cube, while that of martensite is a body-centered cube; thus the atoms in austenite are in the closest packing. As the hardness of a solid solution is largely measured by the value of $\frac{dF}{dr}$, it is quite possible that a distribution having a less close packing of the atoms—martensite—has a greater hardness than that of the closest packing—that is, of austenite.

Two Distinct Kinds of Hardness

The present author's theory of hardening[1] differs wholly or in some respects from some of the other existing theories—that is, β iron theory, the amorphous theory, the solid solution theory, the interstrain theory, and the slip interference theory.

It is first of all necessary to differentiate hardness into two classes according to its origin:

(I) Hardness due to molecular force.

(II) Hardness due to the crystalline structure of metals.

Consider Class I. A pure metal or solid solution is homogeneous; for such substances, the hardness must depend solely on the molecular force, as already explained above. In this case, Tammann's theory[2] of the hardness of solid colutions is quite correct. If two metals are able to mix with each other in all proportions, then the hardness of the alloy generally exceeds that of either of its components, and this hardness has a maximum in an alloy containing an equal atomic quantity of the components. The very fact of miscibility of two metals indicates that the molecular force and its gradient acting between the molecules of different metals are greater than those acting between atoms in the pure metal; and therefore if the two metals form an alloy, the molecular force due to the change of atomic configuration (that is, the hardness) will be greater than that in the respective metals and be maximum in the alloy corresponding to an equal atomic quantity of the components.

Next, let us consider that hardness due to the crystalline structure.

[1] K. Honda, *Sci. Reports*, vol. 6, p. 95 (1917).
[2] Lehrbuch der Metallographie, p. 332 (1914).

Suppose a metal to consist of an immense number of acicular or needle-shaped crystals, which are imbedded in a homogeneous component or in a solid solution and have their lengths all parallel to one another. Such metal very strongly resists tension acting in the direction of the needle crystals, but only weakly the pressure acting perpendicularly to them. This can easily be understood from the analogy of a wire, which can resist a strong tension, though it bends by a small force acting perpendicularly to its length. If the direction of the axes of needle-shaped crystals be uniformly distributed in all directions, then the metal will resist indentation by the Brinell ball very strongly, for the compression will result in stretching a certain fraction of the whole number of needle-like crystals and therefore produce tension in these crystals. A good illustration will be found in the case of the wheels of a bicycle, in which a certain number of spokes radiate from a common center toward the circumference. It is well known that although the spokes are very thin, the wheel can resist a great tension or compression acting in any direction. Hence if a metal contains fine acicular or needle-shaped crystals and their axes are uniformly distributed in all directions, the metal is very hard. By this theory, a metal is harder as its structure is finer and the crystals are in a highly stretched state.

Honda's Theory of Hardness

The above theory may be briefly expressed in the following words: For a given substance having a definite molecular force, its hardness increases with the fineness and the strained state of structure; and for the same structure and the same degree of strain, the hardness of a substance increases with the strength of the molecular force developed by a given change of the configuration in the atoms. This theory, though it is very simple, explains many observed facts in a very satisfactory way. Thus the hardness of solid solution of cementite in iron is partly due to fine martensite or acicular crystals cemented together. These fine crystals will probably be left in highly strained states by rapid cooling, like tightened spokes of a bicycle, thus further increasing the hardness of the solid solution.

Hardening by cold-working or overstraining is also explained in a similar way. This process is analogous to that of tightening the spokes of the bicycle wheels to insure its solidity. Cold-working or overstraining puts fine crystals in a highly stretched state; this state corresponds obviously to the hard state of the substance. In this respect my theory coincides with the interstrain theory; the latter, however, does not explain why interstrain causes greater hardness of the substance, but in my theory this is explained by a well-known mechanical property of the material. By annealing a specimen which has undergone cold-working, the strained state of the minute crystals is released, grain growth takes place, and therefore the hardness decreases on both accounts.

What Is Martensite?

In the theory of hardening this important question arises: Why on quenching a steel in the austenitic state is a martensitic structure instead of an austenitic or pearlitic structure obtained? In metallurgical investigations we very often use the principle that by quenching a metal from a high temperature the structure at this temperature is preserved at room temperature, but the formation of martensite is an exception to this principle, and we feel a great uncertainty with regard to the general result of many heat-treatments. Some metallurgists have considered martensite to be an indefinite semi-transformed substance; but considered from the result of recent investigations, we must consider it to be a perfectly definite phase. From X-ray analysis it is to be concluded that martensite is a different phase from austenite and also that although martensite has the same atomic distribution as ferrite, at least with respect to iron atoms, it contains carbon in solid solution, hence is different in phase from ferrite.

According to the result of some experiments made at the Tôhoku Imperial University which have not yet been published, the heat of transformation from martensite to pearlite is definite and proportional to the content of carbon, amounting to about one-third the heat liberated at the A_1 transformation. This also indicates that martensite has a definite structure. The fact that the hardness and specific volume of martensite are very large in magnitude as compared to both austenite and pearlite disproves the conception that martensite is an intermediate stage of the transformations from austenite to pearlite (or in a strict sense from austenite to troostite).

Theory of Quenching

Having thus far cleared the nature of martensite, we now proceed to consider the theory of quenching.[3] According to my opinion, the so-called A_1 transformation is not a simple but a compound transformation consisting of

$$\text{Austenite} \rightleftarrows \text{Martensite} \rightleftarrows \text{Pearlite}$$

Thus, during a slow or rapid cooling, austenite is at first changed into martensite, which is then transformed into pearlite. During a slow cooling, austenite changes into martensite, and the latter, being at a very high temperature, changes immediately into pearlite. But during a very rapid cooling, such as quenching, the change from austenite to martensite is so far retarded that when this change is completed the specimen is nearly at room temperature, and therefore the next change from martensite to pearlite cannot progress, owing to the high viscosity of the material at that temperature. Hence quenching produces a hard martensitic structure. During heating, the A_1 transformation also consists of the reverse changes—that is, from pearlite through martensite to austenite.

In the above conception it is obvious that the general principle that quenching preserves the state stable at the elevated temperature is not violated in the least by the formation of martensite by quenching. If the quenching is too severe, even the first transformation from austenite to martensite is partly prevented, and therefore at room temperature we obtain a martensitic structure containing a certain amount of austenite. This austenite has a tendency to change into martensite, and in fact changes very slowly at room temperature. Hence the hardness of a severely quenched steel increases with the lapse of time, as has actually been observed.[4]

If the quenched steel be heated at 100 deg. C., the above transformation from austenite to martensite is accelerated, and therefore the increase of hardness goes on more rapidly than at room temperature. But if the heating temperature is too high, say 300 deg., not only the first change but also the second change from marten-

[3] K. Honda, *Sci. Reports*, vol. 8 (1919), p. 181; *Iron & Steel Inst.*, No. 1 (1920).
[4] K. Honda and S. Idei, *Sci. Reports*, vol. 9 (1920), p. 491.

site to pearlite begins to take place, and therefore the hardness decreases as a whole—that is, the steel is tempered.'[5]

It is quite natural that the A_1 transformation consists of a double change

$$\text{Austenite} \rightleftarrows \text{Martensite} \rightleftarrows \text{Pearlite}$$

as is readily seen from the following considerations: From the standpoint of X-ray analysis, it is highly probable that both austenite and martensite are solid solutions of carbon, but not cementite, in iron. But the separation of carbon from its solid solution takes place as cementite; hence for its separation (that is, for the A_1 transformation) austenite will first change into martensite, a configuration more favorable for the separation of carbon as cementite, and then follows the separation of cementite, or what is the same thing, the transformation of martensite to pearlite. As shown below, a similar stepped change also exists in the case of duralumin.

An investigation of duralumin by S. Konno[6] resulted differently from those of P. D. Merica, R. G. Waltenberg and H. Scott[7] in some important points. The following are the chief results of his investigation:

Results of Investigation of Duralumin

1. In quenched duralumin, the softer the quenching the greater the immediate hardness increase, but the gain in hardness by aging as well as the final hardness decreases. In a quenching in oil at 100 deg. C. or higher temperature the aging effect vanishes. On the other hand, the more drastic the quenching the immediate hardness decreases, but the aging effect and the final hardness increase, their maximum values being obtained by quenching the alloy from 500 deg. C. in water.

2. The above effect of quenching is due to the precipitation of copper and magnesium compounds from the aluminum, the process of separation being very slow. Thus duralumin is in a somewhat hardened state; even if it is cooled very slowly from 500 deg. C., a perfect annealing is obtained only by heating the alloy at 350 deg. C. for 1 hour or more.

3. Up to about 6 per cent Cu, alloys of Al and Cu show by quenching an immediate hardening, but very little effect on aging. Hence the immediate hardness is partly due to the precipitation of $CuAl_2$ in Al.

4. With an addition of a small quantity of Mg (0.7 per cent) to the above alloys, an immediate hardening as well as an aging effect becomes prominent, and nearly of the same order as in duralumin. A further addition of manganese increased the quenching effect, viewed as a whole.

5. The aging after quenching is attributed to the precipitation of Mg_2Si from the solid solution of $CuAl_2$ in Al. It is not due to metallic magnesium, because a mere increase of Mg does not result in an increase of aging effect, but an increase of both Mg and Si in the proportion of the compound Mg_2Si magnifies the same effect. As a matter of fact a small quantity of Si (0.5 to 0.7 per cent) is always present in Al as an impurity. The content of Si being assumed to be 0.7 per cent, the effect of quenching, if Mg increases beyond 1 per cent, begins to diminish, and almost vanishes above 3 per cent Mg.

The last three results, 3, 4 and 5, differ from those by Merica, Waltenberg and Scott.

6. From the specific resistance versus temperature curves for quenched duralumin, we conclude that the quenched alloy is tempered at two steps beginning at 210 and 280 deg. respectively. The first step in the curves is due to the partial separation of $CuAl_2$, and the second to that of Mg_2Si.

7. Quenched duralumin expands at room temperature as the aging proceeds, thus being similar to quenched low-carbon steels.

Essential Similarity in Process When Hardening Steel and Duralumin

The above effect of quenching and the accompanying change of physical properties are quite similar to those in severely quenched carbon steels. Hence we can explain the hardening by quenching in exactly the same way as in steels.

As stated above, duralumin contains two compounds, $CuAl_2$ and Mg_2Si. Hardening resulting from quenching may be considered as the effect of Mg_2Si in the solid solution of $CuAl_2$ in Al. The solubility of Mg_2Si begins at about 350 deg. and rapidly increases with the rise of temperature. Let us call $CuAl_2$: Al solid solution containing dissolved Mg_2Si the γ state and that containing Mg_2Si as a mixture the α state. As in the case of cementite dissolved in iron, the separation of the compound is assumed to take place in two steps—that is, γ solid solution is at first changed into β solid solution, whose atomic configuration is favorable for the separation of the compound, and which is also very hard as compared to γ or α state, and then the separation of the compound from β follows. In conformity with the observed facts, the transformations

$$\alpha \rightleftarrows \beta \rightleftarrows \gamma$$

are assumed to progress very slowly.

According to the above theory, by quenching duralumin in water even the first transformation from γ to β is partly arrested, and we obtain β mixed with γ at room temperature. Gamma state, thus quenched, changes at room temperature very slowly into a hard solid solution β; but β changes into α scarcely at all. The consequence is that by quenching, the alloy is hardened and its hardness increases with time. Thus the immediate effect of quenching is determined by the quantity of β present, and the aging effect by that of γ.

If the quenching is very severe, a larger part of γ is preserved at room temperature, only a small remainder being β, so that the aging effect is very large, but the immediate hardness effected is small. As the quenching becomes less drastic, the quantity of β at room temperature increases and that of γ decreases; hence the immediate hardness increases, but the aging effect decreases.

By heating the quenched specimen at a temperature higher than room temperature, say 100 deg. C., the transformation of quenched γ into β is accelerated, so that aging takes place in a comparatively short time, as actually observed. But if the heating temperature is too high, say 300 to 350 deg C., not only quenched γ is changed into β, but also the second transformation of β into α takes place comparatively rapidly, so that the hardness decreases as a whole. This is a case of tempering. The above explanations are given by way of examples, but all results observed are equally well explained by the above theory.

[5] C. Grard, *Proc.*, Sixth Congress, International Association for Testing Materials, III$_2$.
[6] This paper will be published in the near future.
[7] Scientific Papers of the Bureau of Standards, vol. 15, pp. 105, 271; Chem. & Met. Eng., vol. 21, p. 551 (Oct. 29, 1919).

Auxiliary Electrochemical Developments for Hydro-Electric Plants

By H. K. Benson

AUXILIARY electrochemical plants offer many interesting possibilities for the utilization of the off-peak power of municipal hydro-electric developments. In the few instances where such combinations are in operation the load factor has been very favorably advanced.[1] For economic reasons there is always a certain reserve of power and always a certain amount of water going over the spillways. In the Pacific Northwest the seasonal water flow also offers an attractive inducement for an industry that can accomodate itself to the varying supply of power. The characteristics of such an industry are somewhat peculiar. First, there should be no heavy investment of money in machinery or plant, inasmuch as when the power site is fully developed there may be only a comparatively small amount of power for side consumption. Moreover, during certain years there will be no high water, a condition which would lead to the necessity of using all the storage water for power purposes for the regular load. Second, the industry must be of such a nature that it will run on intermittent power and the process must be such that it will be capable of regular shut downs. This is due to the fact that in most daily load curves of power plants there are three peaks or maximums and the power going to the side industry must lie in between these peaks.

An analysis[2] of the chemical processes utilizing electrical power shows only a limited number capable of operating under the conditions above enumerated. For convenience these processes may be divided into two general classes: electrolytic and electrothermal.

Electrolytic Industries

The electrolytic industries consist of the following: (1) Refining processes in which crude metals are deposited on pure cathodes; (2) reduction and oxidation processes for the production of many organic materials; (3) fused metal processes such as the production of aluminum, calcium and sodium, and (4) the caustic potash and soda industries. Refining processes for the metals are carried out under acidic conditions and are not suitable for interrupted power, while the fused metal processes require cells of high heat capacity and consequently not adapted to variable power supply. The oxidation and reduction processes used in the manufacture of vanillin, hydroquinone, para-amidophenol, alizarine, saccharine, aniline blue, congo red and other organic chemicals might in some cases operate on the off-peak loads. But the most important processes which can utilize such loads are those involving the electrolysis of solutions as in the manufacture of caustics, hypochlorites, alkali metals, bromine, fluorine, chromium sulphates, perchlorates, hypochlorites, hydrogen and oxygen. In the caustic industry, for example, two factors are in its favor, since, first, all the extra capital requirement would be confined to the automatic valves to cut off the brine supply when the current from the power plant is needed for the peak load and second, these cells are capable of coming up to normal efficiency in from three-quarters of an hour to one hour.

These processes may be grouped under four classes according to the manner in which electric energy is transformed into the heat energy required for the chemical reaction. These groups are: (1) The arc, which yields the highest temperature and confines the heat to a comparatively small region; (2) resistance furnaces used in the manufacture of abrasives and of iron; (3) the combination arc and resistance processes used in the manufacture of phosphorus and carbon disulphide, and (4) the induction furnaces used in steel manufacturing. Of these processes the arc seems the most suitable for the intermittent power load. It has been thus used successfully for the fixation of atmospheric nitrogen and has been recommended by the British Ministry of Munitions to the House of Parliament for use in England.[3]

In the selection of an industry for the utilization of off-peak power the first choice would lie in the arc process, because of the great advantage the arc process holds over all others due to its low heat capacity and the fact that the cost of production is largely dependent on the cost of power. Second choice rests in the electrolytic processes excepting only the refining of metals. Although their capital requirements are high, depreciation is small and the low price of off-peak power is quite a factor in their costs of production. The third choice lies with the processes using the combined arc and resistance furnace under conditions where seasonal power would be available to maintain the necessary heat capacity of the furnaces continuously or where the margin of reserve power could be similarly utilized.

Recommendations for Skagit Project at Seattle

A detailed study of the particular chemical industry to become an auxiliary of a given hydro-electric plant involves of course its location with respect to raw materials and markets for the products. A careful analysis of such conditions in the case of the new Skagit hydro plant under construction by the city of Seattle has led to the following conclusions:

1. The most suitable means for increasing the load factor of the Skagit project would be the fixation of nitrogen by the electric arc.
2. The production of phosphoric acid by electrochemical means would be the second choice.
3. Hydrogen and oxygen as produced in the electrolytic cell would rank third in suitability excepting only under the condition that there would be established in or near Seattle a hydrogenation industry, in which event this electrolysis would rank second if not first.
4. The electrochemical production of caustic and allied products or of organic chemicals takes fourth place in utilizing the power wastage of the Skagit project.

It is obvious from data gathered in this investigation that close co-ordination between the chemical and electrical engineers in the development of hydro-electric plants will bring forth results of mutual value in the development of these newer phases of industry.

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[1] *Elec. World*, vol. 67 (1916), pp. 581, 582.
[2] From data compiled by D. A. Somerville and A. H. Roos in an engineering thesis, University of Washington.

Extension of Japanese Government Steel Works

The Yawata (Government) Steel Works, in Kiushiu, is now building a mill to manufacture billets for private steel makers. Press dispatches state that the construction program calls for completion of the plant about April, 1924, when a productive capacity of 200,000 tons of billets per year is expected.

[3] Final Report, Nitrogen Products Committee.

Recent Developments in the Sulphuric-Acid Industry—IV*

Description of Two New Types of Nitration Processes for Producing Sulphuric Acid Without the Use of Lead Chambers—Adsorptive and Catalytic Properties of Silica Gel—Conclusion

BY ANDREW M. FAIRLIE
Consulting Chemical Engineer

THE first serious attempt to manufacture sulphuric acid by a nitration process without the use of lead chambers was the invention of Opl, of Hruschau, Austria, patented in the United States in 1911. The Opl process made considerable headway in Europe, but it received little attention, in a practical way, in this country. Recently two other nitration processes, without chambers, have been proposed, and at least one installation of each type has been erected. These two processes are the Kaltenbach pipe process and the so-called "packed-cell" process.

THE KALTENBACH PIPE PROCESS

M. Kaltenbach, after careful consideration of the thermal balances between the heat entering and leaving (*a*) the Glover tower; (*b*) the first two chambers out of a total of four; and (*c*) the last two chambers, came to the conclusion that the defects of the chamber process were the impossibility of obtaining throughout a set of chambers the most favorable reaction temperatures; the unsatisfactory contact between the reacting gases and liquids; the inefficiency of the lead surfaces for the dissipation of heat; and the bulky and expensive construction.[10]

To overcome these defects the pipe process was devised and patented by Kaltenbach. Its main characteristics are: (1) The dissipation of the evolved heat in the immediate vicinity of its generation. (2) The possibility of regulating both the reaction temperature and the acid concentration simultaneously to obtain the most favorable conditions. (3) Intimate contact between the reacting gases and liquids.

The apparatus consists of a multiplicity of pipes or tubes packed inside and water-jacketed outside. The gases leaving the Glover tower proceed through the tubes of successive systems, in counter-current to the acid, which is mixed as required with appropriate quantities of water. The gases are fed to the parallel tubes comprising any group in a series, through a common header, and devices are provided to assure the regular distribution of acids and gases in the tubes. The dimensions and the shape of the tubes have been carefully designed so that the cooling effect of the water jacket may be felt at the center as well as at the walls. The number of tubes installed depends on the volume of gases to be treated.

The following description of the apparatus is taken from the abstract of Kaltenbach's paper:

"In the figure (Fig. 33), which is a diagrammatic representation of this apparatus for making sulphuric acid, 1 is the Glover tower which receives through the pipe 2 the hot gases coming from the furnaces and which discharges these gases through pipe 3 into the first piping system 4, which is made up of a number of tubes, all constructed alike, provided with interior packing of uniform resistance 5, and surrounded by a water jacket 6. The circulation of the water can be regulated by means of the admission valve 7. Each tube can be isolated from the rest of the apparatus by means of the dampers 8 and 9. The gases then pass through the rest of the tubes 10, which are constructed in a similar fashion, and finally through the Gay-Lussac tower 11, which may itself constitute the last pipe system of the series, the only difference being that the temperature is maintained therein at as low a point as possible.

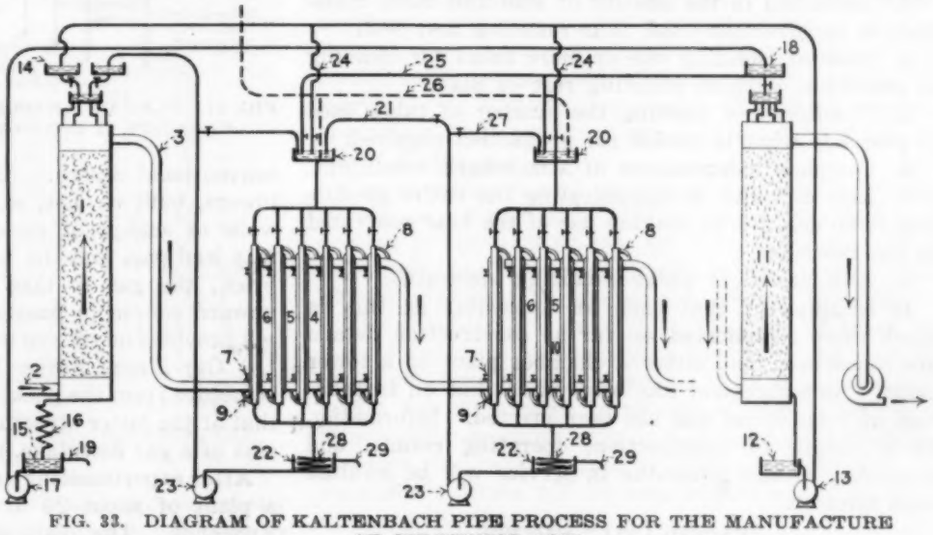


FIG. 33. DIAGRAM OF KALTENBACH PIPE PROCESS FOR THE MANUFACTURE OF SULPHURIC ACID

"The nitro-sulphuric acid (60 deg. Bé.) recovered from the Gay-Lussac tower in the reservoir 12 is raised by means of the pump 13 to the supply tank 14, which feeds the Glover tower. The acid which comes from the tower and is collected in the tank 15, after having first passed through the cooler 16, is partly returned to the Gay-Lussac feed tank 18 by means of pump 17. The surplus acid is removed through the pipe 19 and forms part of the production.

"The pipe systems 4 and 10 are supplied with acid by means of the feed tanks 20, which may receive a regulated quantity of acid through the piping arrangement

*For Parts I, II and III, see CHEM. & MET. ENG., vol. 25, Nos. 19, 20 and 21, pp. 861, 917 and 964.

[10] *Chimie et Industrie*, vol. 3, No. 4, 1920; abstracted by Ismar Ginsberg in *Chemical Age*, vol. 28, p. 295.

21, which conveys the acid recovered in the corresponding system of tubes. The acid is collected in the reservoir 22, and is elevated by the corresponding pump 23 (1) through the pipes 24, connected to the line supply of nitro-sulphuric acid used in irrigating the Glover tower; (2) through the pipes 25, conveying the 60 deg. Bé. sulphuric acid used in irrigating the Gay-Lussac tower; (3) through the pipes 26, connected with the water supply; and (4) through the pipes 27, conveying acid from the catch-tank 22 of the same pipe system. This latter acid from the lower catch-tanks 22 can be cooled by means of an appropriate cooling system. The tanks are provided with outlet pipes, making it possible to remove acid which would correspond to any piping system in the series."

It will be observed that this process not merely tries to eliminate the heat of reaction by a more or less intense external cooling, which is claimed to be twenty times as effective as the cooling effect of air-cooled lead chambers, but that it also combines with that effort the practice used in the tower processes (such as the Opl and the packed cell processes), of circulating cooled acid through packed spaces, in counter-current to the flow of gases.

The advantages claimed for this process are:

1. Great ease of controlling the reaction temperature, by means of the circulation of water in the water jackets, and of cooled acid within the tubes.
2. Effective utilization of the surface of the tubes for the interchange of heat.
3. Reduction in the amount of lead and other materials of construction used, thus reducing first cost.
4. Ease of isolating one or more tubes for cleaning or repairing, without affecting rest of plant.
5. Possibility of limiting the number of tubes used to precisely what is needed for production required.
6. Complete independence of atmospheric conditions.
7. Less difficulty in concentrating the entire production to 60 deg. Bé. by making use of the heat generated in the reactions.
8. Elimination of water-atomizing apparatus.

It is apparent that such an apparatus as this is much more complicated, so far as construction details are concerned, than either a chamber plant or a tower plant. Announcement has been made that an installation of commercial size has been erected. Information as to details of construction, operating results, and durability of the apparatus in service will be awaited with interest.

"Packed Cell" Process

The "packed cell" process, described briefly in U. S. Bureau of Mines Bulletin No. 184,[11] is the invention of E. L. Larison, of the Anaconda Copper Mining Co., Anaconda, Mont. The process is protected by U. S. Patent 1,342,024, issued June 1, 1920. Another patent, U. S. 1,334,384, covers special features of tower construction, designed by Larison.

The packed cell process is a nitration process, and in its use of acid-sprayed packed towers, or "cells," instead of lead chambers, for the reaction spaces it resembles more the European Opl process than any other. For the operation of the process a specially designed "packed cell plant" was needed.

In designing a type of plant which would give promise of being less costly, less bulky and more efficient than the conventional chamber plant, two desirable features of operation were kept in mind, together with the idea of adapting to these features a recent development in chemical tower construction, previously referred to."[12] These three ideas were: First, to construct an apparatus in such a way that the gas mixture from the Glover tower would be made to impinge vigorously on surfaces wet with sulphuric acid of specific gravity too low to effect appreciable absorption of oxides of nitrogen; second, to control the temperature of the reacting gases by circulating in direct contact with them quantities of cool weak acid; third, having provided for the removal of the reaction heat by means other than by radiation through metallic walls, to dispense altogether with lead chambers and adapt acid-proof masonry towers (now at a satisfactory stage of development), internally packed, to the new design.

These considerations led to a design of plant including essentially the following: (1) A Glover tower of

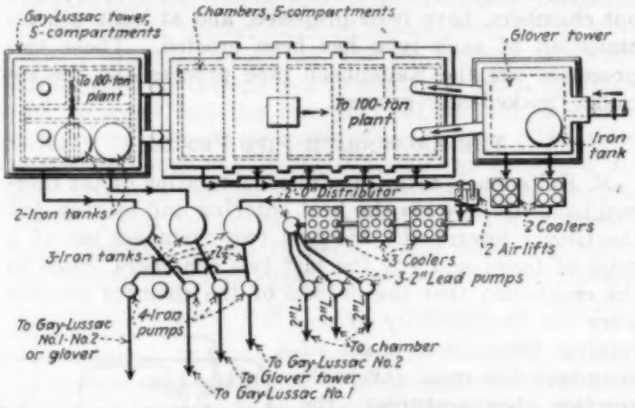


FIG. 34. PLAN OF ANACONDA PACKED CELL ACID PLANT. CAPACITY 21 TONS OF 60 DEG. BE. ACID PER DAY

conventional design. (2) A series of packed cells, or towers, built *en bloc*, exterior walls as well as interior walls of acid-proof masonry, the whole structure built in a lead pan, and the towers packed with checkerwork brick; the gas to take an alternately downward and upward course in passing through the cells; and each cell provided on the top with acid-distributing apparatus. (3) Gay-Lussac towers built *en bloc*, but as a separate structure from the packed cells. Construction similar to that of the latter structure, with the exception of provision of a gas downtake, unpacked, between Gay-Lussacs.

After experimenting on a small scale with this process, a plant of about 20 to 25 tons capacity was built at Anaconda. The plant consisted of one Glover tower, five packed cells in series and two Gay-Lussac towers, and is shown in plan and elevation in Figs. 34 and 35. Referred to the total packed cell space, the packed Glover space was about 15 per cent, and the packed Gay-Lussac space was about 60 per cent. At this plant the packed cell and Gay-Lussac structures were sheathed with 6-lb. lead. After the operating conditions were established, part of the lead sheathing was removed to determine whether acid or gas leakage through the acid-proof masonry was serious. It was found that gas leakage was negligible and acid leakage was slight. As the acid leakage made the wall wet, a 4-in. veneer wall was laid 2 in. away from the main wall and tied into the latter at suitable intervals with brick. This, it is said, made a gas-tight wall and a dry, clean outside.

The gas, derived from roasting copper concentrates,

[11] Wells and Fogg, "The Manufacture of Sulphuric Acid in the United States," pp. 111-114 (1920).

[12] See Part II, CHEM. & MET. ENG., vol. 25, No. 20, p. 917.

was forced into the acid plant by a Buffalo Forge Co. volume blower, with cast-iron housing, plate runner and water-cooled bearings, which was located between the burners and the Glover tower. For pumping the acids, direct-connected motor-driven vertical centrifugal pumps were installed, iron ones for 60 deg. acid and lead or lead protected pumps for weaker acid. Coolers of conventional design were provided for cooling the Glover acid and the cell acids; and provision was made for introducing warm acid into the later cells and cold acid into the earlier cells, with a view to maintaining favorable reaction temperatures throughout. The final cell of the series of five, however, was fed with generous quantities of cold acid, in order to cool the gas mixture prior to entry into the first Gay-Lussac tower. For hydration, neither steam jets nor water atomizers were used; but water, added to the circulating cell acids in the proportions required, was introduced into the acid-distributing boxes at the tops of the cells.

This plant was first operated in May, 1919. Operating on a rather irregular roaster gas, the actual acid production, over a period of several months, is stated to have been at the rate of (nearly) 4 lb. of 60-deg. acid per cu.ft. of packed cell space; or, in other words, 1 cu.ft. of gross packed cell space was employed per lb. of sulphur recovered as acid.

The actual capacity of the plant is given as 21 tons of 60-deg. acid per day.

In order to produce sulphuric acid in as small a reaction space as 1 cu.ft. per lb. sulphur per day, it was

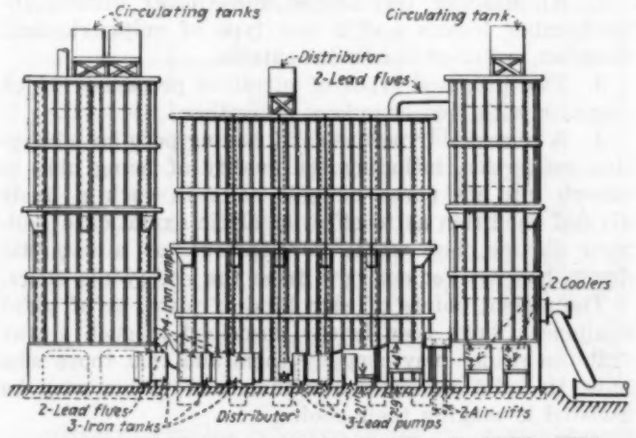


FIG. 35. ELEVATION OF ANACONDA PACKED CELL ACID PLANT

necessary, as had been expected, to increase greatly the concentration of nitrogen oxides in the gas mixture within the reaction spaces provided. The proportion of nitrogen oxides usually carried in circulation in the gas of a chamber plant, operating at the rate of 8 or 10 cu.ft. of chamber space, expressed in terms of nitrate of soda, is from 21 to 25 parts of nitrate of soda per 100 parts of sulphur. In the packed cell process the total amount of nitrogen oxides in circulation, expressed in the same terms, was about 70 parts of nitrate of soda per 100 parts of sulphur, or about three times the usual concentration. This feature of making sulphuric acid from a gas mixture containing oxides of nitrogen and oxides of sulphur in the proportion derived from not less than ½ lb. of sodium nitrate per lb. of sulphur (a 50 : 100 ratio) appears prominently in Larison's patent claims. As compared with a chamber plant operating at the average rate of 10 cu.ft. of space per lb. of sulphur per day, the packed cell plant made acid, according to the figures given, at an increase in reaction speed of 900 per cent. Just how much of this increase is attributable to the increase in concentration of nitrogen oxides in the gas mixture and how much is due to more vigorous impingement of the gases on the surfaces of the cell packing is not definitely known; but if we assume that the reaction velocity increases directly with the concentration of nitrogen oxides in the gases, the reaction space required per lb. of sulphur per 24 hours was reduced to 3.33 cu.ft. by increasing the niter concentration; and impingement of the gases on the cell packing was perhaps accountable for the further increase in reaction velocity, referred to the latter space (3.33 cu.ft.), of 2.33 per cent, bringing the required cell space down to 1 cu.ft. per lb. sulphur per 24 hours.

Wells and Fogg state[10] that the niter consumption at this plant at the start of operations was 6 per cent, referred, presumably, to sulphur in acid made. Later advices give the niter consumption as 4.8 per cent on sulphur in acid made, and tests made on the Gay-Lussac exit gases indicate that with additional Gay-Lussac space the niter consumption might be brought down to a little under 4.0 per cent. The nitrosity of the nitrous vitriol is carried at 70 to 80 oz. $NaNO_2$ per cu.ft.

The optimum temperature of the acid fed into the several cells is not given, as it is stated to be variable with varying conditions. The quantity of water required for cooling the acids is given as about 2,500 gal. per ton of 60-deg. acid produced.

The gas pressure at the exit of the hot gas blower is carried at about 1.2 in. of water. No figures are available as to the power required to drive the gas through the resistance offered by the packing of the packed cells, as compared with the power required for moving gases at a chamber plant. The power used for pumps and fans combined amounts to about 2 hp. per ton of 60-deg. acid.

The quantity of acid circulated over the Gay-Lussac towers amounts to about 300 per cent of the daily production in terms of 60-deg. Bé. acid. The quantity of acid introduced into the packed cells amounts to about 10 tons of 50-deg. Bé. acid per ton 60-deg. Bé. acid.

The advantages claimed for this type of plant are a saving of 40 to 50 per cent in first cost, and a saving of 80 per cent in ground space. The Anaconda plant is not yet old enough to permit of giving figures as to maintenance expense; it is believed by the designer, however, that over a period of years both operating and maintenance costs will be somewhat lower than at the ordinary chamber plant.

Silica Gel

Silica gel, prepared by treating a solution of silicate of soda, under special conditions, with dilute hydrochloric or sulphuric acid, followed by coagulation, drying, washing and partial dehydration, is an agent which has been proposed for a variety of uses in the sulphuric-acid industry.

The method of making silica gel is the invention of W. A. Patrick of Baltimore, Md., and is protected by U. S. Patent 1,297,724. A patent covering a method and apparatus for the separation of vapors and gases by means of silica gel (U. S. 1,335,348) has been issued to W. A. Patrick, B. F. Lovelace and E. B. Miller. Basic facts and observations relative to the adsorption of vapors and gases by silica gel, with special reference

[10] *Op. cit.*, p. 112.

to the adsorption of sulphur dioxide, have been published by E. B. Miller in a paper presented before the American Institute of Chemical Engineers in 1920.[20]

Silica gel is prepared under carefully standardized conditions, and when dried and "activated" by passing through it for 2 hours air heated to 125 to 150 deg. C. it has a moisture content of 5 to 7 per cent. It is a semi-transparent, glassy, brittle, highly porous solid.

Miller's paper describes and illustrates several types of bed absorbers, wherein gases or vapors may be adsorbed in granular gel; and also refers briefly to a pulverized-gel absorber, whereby the activated gel, ground to from 80 to 200 mesh, is fed into the stream of gas to be adsorbed, which escapes through a dust filter, and the adsorption takes place in the gas conduit and in the filter bags. The dust is shaken from the bags into a regenerator, in which by means of heat the adsorbed gas is recovered, and simultaneously the gel-dust is reactivated for use again.

Thus far the only practical application of silica gel to industrial use on a commercial scale has been for the adsorption of gasoline vapor in oil-refining processes, but the same type of apparatus is said to be adapted to the recovery of a variety of industrial gases. For some time the Davison Chemical Co., which holds the patent rights, has been experimenting with various propositions for using silica gel in the sulphuric-acid processes.

Uses For Silica Gel in Sulphuric-Acid Industry

Some of the ways in which it has been proposed to use silica gel for effecting economies in the manufacture of sulphuric acid are the following:

1. The adsorption of sulphur dioxide from gas mixtures containing only a small percentage of that gas, followed by the recovery of the sulphur dioxide from the gel, for the purpose of producing a gas mixture strong in sulphur dioxide. By this means it is stated that a gas mixture containing, for example, one-half per cent SO_2 can be used for producing a gas mixture containing 8 per cent SO_2 or more.

Experiments have shown that the gel is capable of adsorbing, from a gas mixture containing 8.75 per cent SO_2, 6.8 per cent of its weight of sulphur dioxide, at a mean temperature of 40 deg. C. Less concentrated gases are less efficiently adsorbed. For further data the reader is referred to Part I of Miller's article.[21]

2. The adsorption in silica gel of the SO_2 in the gas mixture of a chamber plant, after passage through only the first half of the chambers, and the recovery of the adsorbed SO_2, to make a gas mixture strong in SO_2 to reintroduce into the first chamber. It is a well-known fact that the latter half of the chambers of a chamber plant do relatively little work, as compared with the first half, and by this means it is proposed to eliminate the inefficient latter half of the chamber space now employed, and cause all the oxidation and condensation to be done in the efficient first half.

3. The recovery of sulphur dioxide and nitrogen peroxide from the gas mixture escaping from the Gay-Lussac tower. Also the indirect recovery of nitric oxide from the same source, by oxidizing the latter to nitrogen peroxide, with subsequent adsorption in silica gel. The extent to which nitrogen peroxide in the gas mixture escaping from the Gay-Lussac tower can be adsorbed in a practical way in silica gel is now being determined experimentally at the plant of the Davison Chemical Co.

4. The recovery of sulphur dioxide and nitrogen peroxide from the gas mixture issuing from the last chamber of a chamber plant as a substitute for the Gay-Lussac tower, thus eliminating the latter.

5. The conversion of SO_2 to SO_3 catalytically, by passing the gas through gel previously treated with special catalyzing agents, such as certain metallic salts. By means of platinized silica gel, such a conversion has been obtained experimentally. Experiments on the catalytic efficiency of a variety of metallic salts adsorbed into the pores of silica gel have been in progress for some time at the Davison laboratories. It seems premature at present to make any very definite claims for the future of metalized silica gel as a catalytic agent on a commercial scale.

Conclusion

In reviewing this series of articles it will be noted that the following recent developments in the sulphuric-acid industry have been considered:

1. A variety of new kinds of plant equipment, such as electrically driven acid pumps, acid valves and gas blowers of various designs and materials, and electrical apparatus for the precipitation of dust, all of which have been put on the market with a view to supplanting established equipment used for the corresponding purposes, considered to be less efficient, less durable or more expensive than the new.

2. All-Masonry Gay-Lussac and Glover towers, interchamber towers and a new type of sulphuric acid chamber, water-cooled on its outside.

3. Two proposed types of nitration processes, which dispense with lead chambers altogether.

4. A remarkably porous solid, having peculiar adsorption properties, including the quality of being able to adsorb into its pores metallic salts in such a finely divided condition as to effect catalytic oxidation of sulphur dioxide, but whose development, as a catalytic agent, has not yet emerged from the embryonic stage.

The salient points of each kind of plant, or of plant equipment, have been briefly described in such a way that the reader may compare them and that those who have to build or equip sulphuric-acid plants may be assisted in making their choice.

Acknowledgments

For information, photographs and drawings used in the preparation of this series of papers the author is indebted to the following gentlemen: Peter S. Gilchrist, president, Chemical Construction Co.; J. N. Houser, manager, Tennessee Copper Co., E. L. Larison, superintendent acid department, Anaconda Copper Mining Co.; E. B. Miller, vice-president, Davison Chemical Co.

For furnishing illustrations and detailed information relative to recent developments in sulphuric-acid plant equipment the author wishes to express his thanks to the following business houses: Chemical Equipment Co., Chicago, Ill.; Chemical Pump & Valve Co., Perth Amboy, N. J.; Duriron Co., Dayton, Ohio; Charles S. Lewis & Co., St. Louis, Mo.; Monarch Manufacturing Works, Philadelphia, Pa.; Packards & James Fison (Thetford), Ltd., Ipswich, England; Research Corporation, New York, N. Y.; Schutte & Koerting Co., Philadelphia, Pa. Other acknowledgments have been indicated at appropriate places in the text, and in footnotes.

Atlanta, Ga.

[20] Chem. & Met. Eng., vol. 23, Nos. 24, 25 and 26, pp. 1155, 1219, 1251, Dec. 15, 22 and 29, 1920.

[21] Chem. & Met. Eng., vol. 23, No. 24, p. 1155, Dec. 15, 1920.

Heat-Treatment of Brass and Brasses Containing Tin*

Brasses Containing a Little Beta Respond to Heat-Treatment—Tin-Brasses, Developing a Special Constituent Analogous to Delta in Bronzes, May Have Their Physical Properties Changed Very Notably by Proper Annealing and Quenching

BY LÉON GUILLET

IT IS known that certain industrial alloys of copper and zinc may be hardened by quenching. Under the microscope these alloys show both the α and β constituent, or if formed of pure alpha are practically saturated in zinc. Industry has not yet made use of this heat-treatment, no doubt because the most of those who use the metal completely ignore this property, and perhaps also because the hardening action is not very pronounced.

A systematic study has been made upon special brasses, which has led the author to form the general conception of the coefficient of equivalence.[1] Further

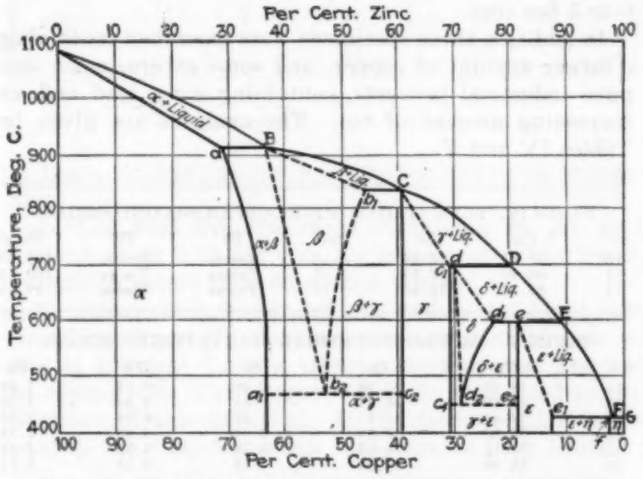


FIG. 1. EQUILIBRIUM DIAGRAM FOR COPPER : ZINC ALLOYS
After Gulliver, "Metallic Alloys," p. 267.

investigations on the influence of the different elements upon the properties of the heat-treated alloys should be useful, especially if the determinations are based upon an exact knowledge of the position of the transformation points. Attention has been attracted to brasses containing tin, for the following important reason:

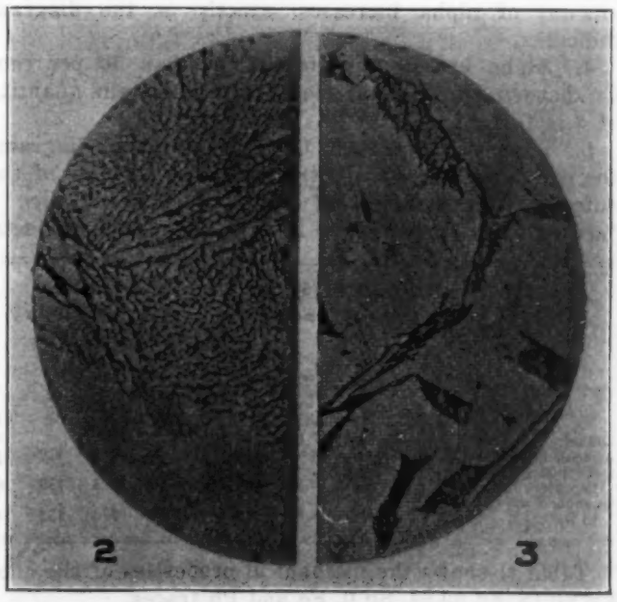
The tin-brasses contain a special constituent which bears a strange resemblance to the delta constituent of bronzes (a solid solution very closely corresponding to the compound Cu_4Sn). This constituent is accompanied by hardness and brittleness; it injures the mechanical qualities of the alloy, especially when present in sufficient amount. Heat-treatment does not cause the disappearance of this constituent, and therefore does not materially improve the properties of the tin-brasses.

Quenching has a strong influence upon the structure of copper: zinc alloys which forecasts the equilibrium diagram, when taking into account the fact that the eutectoid is not resolved—a veritable troostite is found instead.

Brasses formed of α plus β solutions,[2] quenched from above 475 deg. C., have their content in α diminished, whereas the constituent that reminds one of troostite becomes more apparent; nevertheless, this constituent is less readily etched, and is present in a polyhedral form. No doubt quenching prevents the separation of the constituents of this metaral, as seems to be indicated by its easy coloration, and the constituent thus obtained can be better compared to the gamma iron in steels than to the troostite of the same alloys. This seems to be β solution as it exists at a high temperature. (See Fig. 2.)

When the temperature is increased the α solution almost completely disappears and pure β is approached. It has been noted, however, that in the interstices of the grain boundaries there are some traces of α plus β in a finely divided state; complete solution appears to be difficult, at least for brass rich in α solution.

On the other hand, the equilibrium diagram shows a line aa_1 (Fig. 1) separating the region of pure α from that of α plus β, which is a curve bent toward the Y axis. It follows that alloys containing 63 to 72 per cent of copper, when carried to a proper temperature, are no longer in the α zone, but cross into the zone where some β solution is formed. Cooling quickly from



FIGS. 2 AND 3. BRASSES QUENCHED IN WATER FROM 850 DEG. C. ETCHED WITH ANHYDROUS IRON PERCHLORIDE
Fig. 2. 60 : 40 brass, ×50. Fig. 3. 65 : 35 brass, × 430.

*From *Revue de Métallurgie*, July 1921, pp. 445-58.

[1] "Ternary Brasses," CHEM. & MET. ENG., vol. 24, p. 177, Jan. 26, 1921. "Nickel Brasses," CHEM. & MET. ENG., vol. 24, p. 261, Feb. 9, 1921. "Cobalt Brasses," CHEM. & MET. ENG., vol. 24, p. 439, March 9, 1921: "Coefficients of Equivalence in Ternary Alloys," CHEM. & MET. ENG., vol. 24, p. 609, April 6, 1921.

[2] In industrial brasses this comprises those containing from 55 to 63 per cent copper, and also includes those containing the unresolved constituent frequently called "apparent beta."

such temperature, the resulting alloy will be formed of these two constituents. (Fig. 3.) This is a very interesting hardening (by quenching) by simply heating the specimen through a line in the diagram not belonging directly to a eutectoid.[3]

A little of the β is clearly to be seen in this quenched alloy (Fig. 3). Quenching does not affect the mechanical properties to a great extent; no doubt this is due to the non-resolution of the eutectoid, leading to the supposition of a "semi-quenched" state existing as a matter of course in alloys formed of α and "apparent β"; the "apparent β" seems to be a veritable troostite replacing the eutectoid between α and γ solutions. Besides, quenching does not produce a martensitic structure in brass, at least as far as is known.

In Table I is presented a series of Brinell tests[4] published in 1914 bearing on this subject.

TABLE I. HARDNESS OF QUENCHED BRASSES

Cu, per Cent	Annealed at 750 Deg. C.	Quenched in Water at 420 Deg. C.	520 Deg. C.	620 Deg. C.	720 Deg. C.	820 Deg. C.	850 Deg. C.
56	126	134	136	121	124	126	Broken
58	109	102	116	124	131	128	135
60	88	92	94	101	114	134	137
62	81	82	84	82	100	115	110
65	59	62	60	63	63	76	81
70	59	63	62	61	62	56	57

Recently the following Brinell hardness tests have been made on a brass having 55 per cent Cu and formed therefore of "apparent β," sensibly pure:

Annealed state, 111.
Quenched at 650 after heating for 10 minutes, 119.
Quenched at 750 after heating for 10 minutes, 118.
Tuenched at 850 after heating for 10 minutes, 118.

The following conclusions may be drawn:

1. Quenching increases the hardness of brasses; the increase sometimes reaches 30 Brinell units, more often it does not exceed 10. Finally, certain brasses are not appreciably hardened by quenching.

2. In brasses showing α plus apparent β under the microscope, the hardening upon quenching is a function of the amount of α constituent; brass formed wholly of apparent β is hardly affected by quenching.

3. The necessary quenching temperature to obtain the maximum hardness is proportionally higher as the amount of alpha increases, exactly as the diagram indicates.

4. Alpha brasses containing less than 70 per cent Cu harden slightly on quenching; a certain quantity of β is formed.

5. These facts conform to the equilibrium diagram; the existence of a "troostitic" structure in place of the eutectoid between α and β constituents indicates a "semi-hardened" condition in the unquenched products.

TABLE II. MECHANICAL PROPERTIES OF 60:40 BRASS

	Tension Tests: Ultimate Strength	Elastic Limit	Elongation	Contraction	Impact Tests: Resilience	Angle, Deg.	Hardness
Rolled	54,000	17,100	48.0	51.7	14.3	...	93
Annealed at 800 deg. C.	52,000	14,600	50.0	62.2	17.5	110	78
Quenched at 600 deg. C. in water	51,500	?	36.0	52.7	13.3	139	92
Quenched at 800 deg. C. in water	53,000	33,100	8.0	11.5	7.8	153	145

Table II shows the mechanical properties of the alloy Cu 60.15, Zn 39.84, Sn 0, Fe and Pb traces.

There is a discrepancy between the hardness and the tension tests after quenching at 800 deg. C. This must be attributed to overheating, since the fracture showed a coarse grain.

[3] This seems also to be the case with duralumin.
[4] *Revue de Métallurgie, Memoirs*, 1914, p. 1128.

Composition of the Tin-Brasses

For this investigation ingots cast with square lugs were used, a form which the author has described many times.[5] The lugs are used for the tests on the cast metal, and the center of the ingot is to be rolled hot. All of the ingots had square lugs, 25 mm. on a side attached to a central round of 100 mm. diameter, 250 mm. long. A series of very pure alloys were made. Their analyses are given in Table III.

TABLE III. ANALYSES OF TIN-BRASSES (FIRST SERIES)

No.	Cu	Zn	Sn	Fe	Pb	Total
1	60.15	39.84	0.00	Traces	Traces	99.99
2	60.52	39.31	0.16	Traces	Traces	99.99
3	60.25	39.19	0.52	Traces	Traces	99.96
4	60.41	38.79	0.78	Traces	Traces	99.98
5	60.46	38.67	0.85	Traces	Traces	99.98
6	60.64	38.32	1.02	Traces	Traces	99.98
7	60.50	38.26	1.23	Traces	Traces	99.99
8	61.57	35.33	3.01	Traces	Traces	99.91
9	61.12	33.86	4.89	Traces	Traces	99.87

On the whole, in this series the amount of copper remained between 60.1 and 60.6, the tin increased from 0 to 5 per cent.

In addition three specimens were examined containing a larger amount of copper, and some others, much less pure industrial products, containing some lead and an increasing amount of tin. The analyses are given in Tables IV and V.

TABLE IV. PURE ALLOYS; HIGH COPPER (SECOND SERIES)

No.	Cu	Zn	Sn	Fe	Pb	Total
10	67.61	30.84	1.60	Traces	Traces	100.05
11	80.59	17.85	1.57	Traces	Traces	100 23
12	80.23	16 47	3.15	Traces	Traces	99.05

TABLE V. IMPURE INDUSTRIAL ALLOYS (THIRD SERIES)

No.	Cu	Zn	Sn	Fe	Pb
13	59.38	37.90	0.00	0.69	1.88
14	58.80	38.25	0 63	0.52	1.70
15	59.13	37.45	1.12	0.44	1.78
16	58.98	37.65	0.31	0.48	2.74
17	59.12	36.83	0.76	0.67	2.58
18	58.90	36.65	1.18	0.53	2.72

The studies have included (1) micrographic examination; (2) determination of transformation points; (3) mechanical tests in the cast state for the first and second series; mechanical tests in rolled, drawn and annealed state for the first and third series, with the exception of the 3 and 5 per cent tin alloys; mechanical tests on all alloys, in the quenched condition.

All ingots except 8 to 12 inclusive were rolled to 22-mm. round bars, and then drawn to 20 mm. diameter. Annealing was done at 800 deg. C. in oxide of iron (in order to avoid that loss by volatilization in a reducing atmosphere indicated in researches made in collaboration with M. Ballay). This relatively high temperature was adopted to secure greater homogeneity.

Quenching was done in water after heating 15 minutes at 600 or at 800 deg. C.

Determination of Critical Points

Critical points were determined with a Saladin-Le Chatelier double galvanometer; the comparison specimen was copper; temperature reached in the heating was from 800 to 850 deg. C.; heating time was 1 hour 15 minutes; cooling required 1 hour 30 minutes to pass

[5] *Revue de Métallurgie, Memoirs*, 1906, p. 247.

TABLE VI. THERMAL ANALYSIS OF ALLOYS

No.	Amount in Cu	Amount in Sn	Transformation Points Heating	Transformation Points Cooling
1	60.15	0.0	456, 750	705, 445
2	60.52	0.16	445, 760	720, 445
3	60.25	0.52	445, 740	690, 445
4	60.41	0.78	445, 745	700, 445
5	60.45	0.85	445, 740	700, 440
6	60.64	1.02	445 *480*, 740	690, 445
7	60.5	1.23	445, *490*, 730	680, 440
8	61.57	3.01	*500*, *760*	*720*, *500*
9	61.12	4.89	*530*, *710*	*630*, *520*
10	67.61	1.60	*560*	*540*
11	80.59	1.57	.....	.....
12	80.23	3.15	.....	.....

from 850 to 200 deg. C. The results obtained are given in Table VI. Italic figures indicate abnormal points —that is to say, those which are not found in tin-free brasses. Fig. 4 reproduces some of the curves obtained.

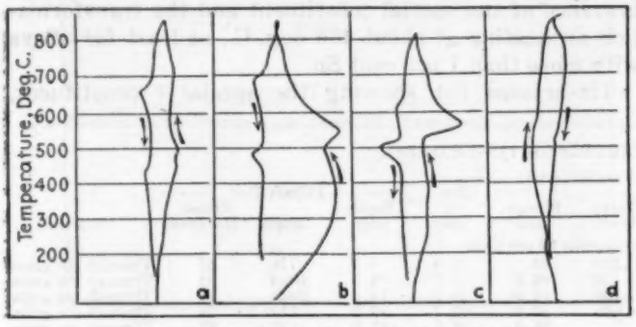


FIG. 4. HEATING AND COOLING CURVES
a, alloy 7; *b*, alloy 8; *c*, alloy 9; *d*, alloy 10.

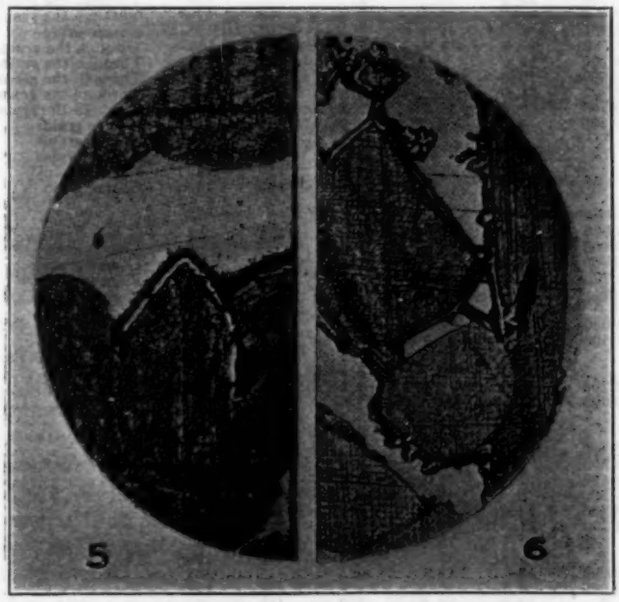
These determinations lead to the following conclusions:

1. The first five specimens containing 60 per cent Cu and up to 0.85 per cent Sn possess no other transformation points than do normal brasses.

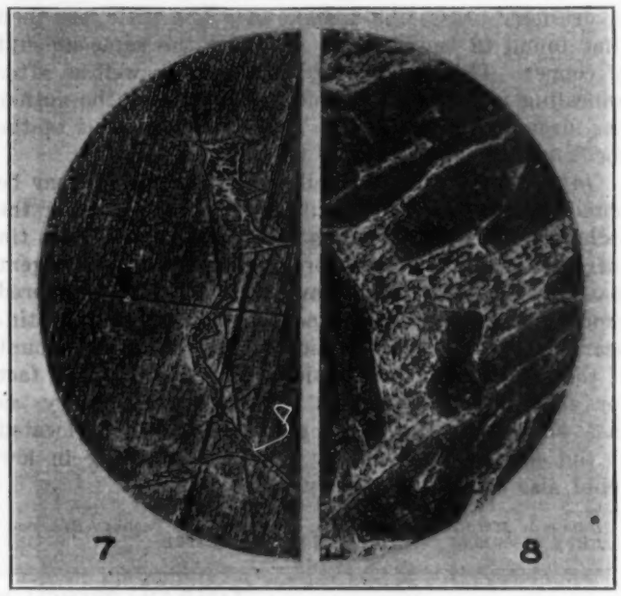
2. Alloys with 60 per cent Cu and 1 to 1.3 per cent Sn (Nos. 6 and 7) absorb a small amount of heat at 480 to 490 deg. C.; this thermal anomaly was not met in cooling; its disappearance may be attributed to the slowness of the operation. If the determination is repeated, the transformation reappears at each heating; it is not due, therefore, to the heterogeneity of the specimen.

3. The alloys containing 60 per cent Cu with 3 to 5 per cent Sn present two points, due to the presence of tin, since the micrographic examination shows that these products do not contain apparent β. It will be shown that these points correspond to the beginning and the end of solution of the special constituent. Furthermore, the anomalies increase as the tin increases.

4. As copper increases, the amount of tin necessary to induce unusual transformation points also increases; thus none were found in an alloy containing 80 per cent copper and 3 per cent tin.



FIGS. 5 AND 6
Fig. 5. Cast brass; Cu 60.46, Sn 0.85; white is beta, gray is alpha constituent, rim is special delta constituent due to tin. × 430.
Fig. 6. Annealed brass; Cu 60.50, Sn 1.23. × 430.

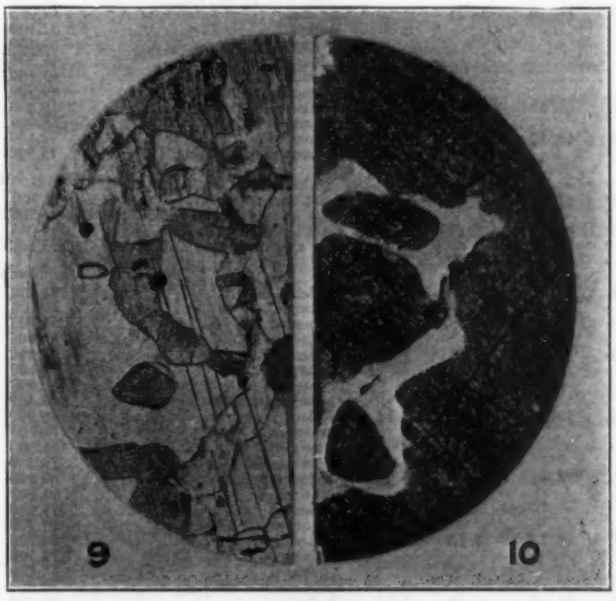


FIGS. 7 AND 8. DELTA CONSTITUENT IN EUTECTOID IN HIGH-TIN BRASSES. × 200
Fig. 7. Cu 67.6, Sn 1.50. Fig. 8. Cu 61.6, Sn 3.05.

MICROGRAPHS OF CAST OR ANNEALED SAMPLES

Microscopic observations made after etching with acid iron perchloride may be summarized as follows:

Alloys 1 to 4 are formed of the α and β constituents



FIGS. 9 AND 10. QUENCHED TIN-BRASSES. × 200
Fig. 9. Cu 60.64, Sn 1.02; quenched from 600 deg. C.
Fig. 10. Cu 67.6, Sn 1.5; quenched from 650 deg. C.

of ordinary brass; the amount of α is a little less than that found in tin-free alloys having the same amount of copper. This is true for cast metal as well as after annealing at 800 deg. C., and confirms what the author has already written on this subject.[6] The value of the coefficient of equivalence of tin is about 2.

On the other hand, the following phenomenon may be noted very clearly: Constituent β is attacked by the etching reagent with much more difficulty as the tin increases, so that after a prolonged attack the reagent may cause the β to appear white against a colored ground mass of α. This is perhaps one reason why tin-bearing brasses have been successfully used on account of their resistance to corrosion. Fig. 5 shows this fact for alloy 5 (0.85 per cent Sn). The same alloy, as cast, shows a little of the special constituent, located at the edge of the white β region. Polishing in low relief also shows this clearly.

Annealing at 800 deg. C. for 2 hours causes this small quantity of special constituent to disappear; it may be designated by the letter δ.

When the amount of tin reaches 1 per cent, the constituent exists in the annealed metal as well as in the metal as cast (Fig. 6), and its proportion increases with tin, so that brasses 8 and 9, with 3 and 5 per cent Sn respectively (Figs. 7 and 8), have the same appearance as bearing bronzes.

Examination of brass containing more than 60 per cent Cu shows that as the amount of zinc decreases a greater quantity of tin may enter into solution in the α constituent. For instance, with 67 per cent Cu, the amount of δ constituent is very slight for 3.6 per cent Sn; it is zero with 80 per cent Cu and 3 per cent Sn.

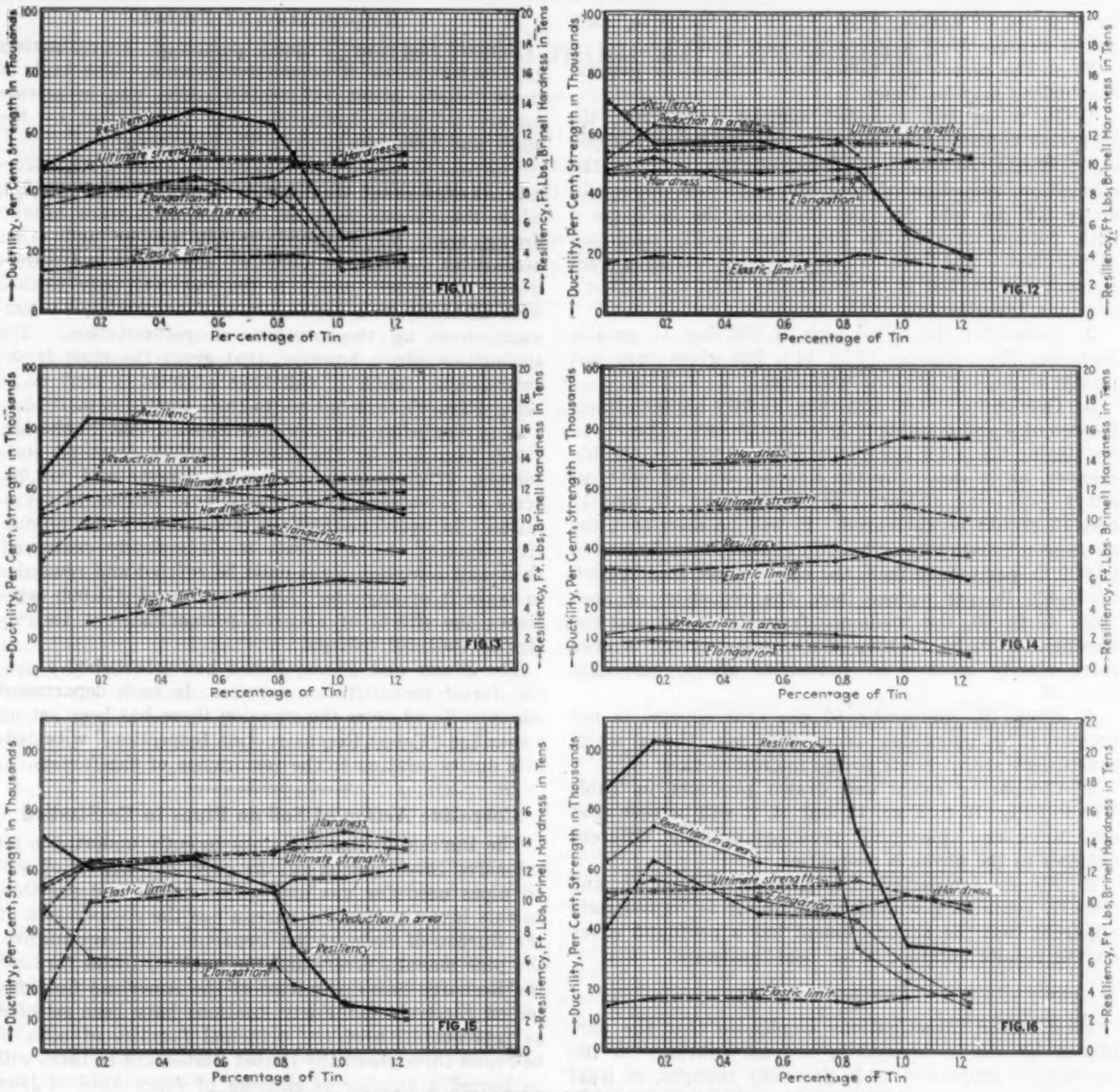
Absolute agreement should be noted between the appearance of the special constituent and the transformation on heating at about 480 deg. C., at least for alloys with more than 1 per cent Sn.

Tin-brasses not showing the special δ constituent,

[6] *Revue de Métallurgie, Memoirs*, 1906, p. 264: "Ternary Brasses," CHEM. & MET. ENG., vol. 24, p. 177, Jan. 26, 1921.

TABLE VII. PHYSICAL PROPERTIES OF TIN-BRASSES

Alloy No.	Composition: Copper	Tin	Lead	Condition	Tensile Test: Ultimate Strength	Elastic Limit	Elongation	Red. in Area	Impact Test: Resilience	Angle	Brinell Hardness	Fracture
				A. Pure Alloys. Copper Approximately 60 per Cent								
1	60.15	0.00	....	As cast	47,500	13,200	38.	35.4	9.7	126	83	Through the grain
				Rolled	54,000	17,100	48.0	51.7	14.3	Bent	93	Through the grain
				Drawn	54,000	17,100	48.0	54.7	14.3	Bent	93	Through the grain
				Annealed	52,100	14,600	50.0	62.2	17.5	110	79	Through the grain
				Quenched at 600 deg. C.	51,400	?	36.0	52.7	13.3	139	92	Through the grain
				Quenched at 800 deg. C.	53,100	33,100	8.0	11.5	7.8	153	145	Coarse grain
2	60.52	0.16	....	As cast	48,000	14,600	42.0	38.9	11.25	133	82	Through the grain
				Rolled	54,500	18,900	52.0	63.0	11.25	137	87	Through the grain
				Drawn	62,600	49,200	31.0	63.0	12.2	142	127	Through the grain
				Annealed	53,500	17,100	57.0	74.3	20.6	Bent	126	Through the grain
				Quenched at 600 deg. C.	57,700	15,100	50.0	63.9	16.8	Bent	94	Through the grain
				Quenched at 800 deg. C.	52,100	32,100	9.0	12.8	7.7	158	136	Coarse grain
3	60.25	0.52	....	As cast	50,900	17,900	41.0	45.5	13.5	140	88	Through the grain
				Rolled	54,900	17,500	41.0	61.2	11.5	142	94	Through the grain
				Drawn	64,400	52,000	29.0	57.5	12.8	153	134	Through the grain
				Annealed	54,500	17,100	50.0	62.2	20.0	Bent	92	Through the grain
4	60.41	0.78	....	As cast	50,700	18,900	40.0	35.4	12.5	137	90	Through the grain
				Rolled	56,900	17,500	45.0	58.5	10.0	159	97	Through the grain
				Drawn	66,300	53,100	29.0	52.7	10.9	160	136	Through the grain
				Annealed	54,900	16,100	45.0	61.2	20.0	Bent	93	Through the grain
				Quenched at 600 deg. C.	61,500	20,700	45.0	57.5	16.25	131	105	Through the grain
				Quenched at 800 deg. C.	54,000	36,000	7.0	10.8	8.1	164	140	Coarse grain
5	60.46	0.85	....	As cast	51,300	18,900	35	41.1	10.6	138	98	Coarse grain
				Rolled	56,900	19,900	45.0	52.7	9.6	148	96	Coarse grain
				Drawn	67,300	56,900	22.0	43.3	7.5	164	140	Coarse grain
				Annealed	56,900	15,100	43.0	34.3	15.0	126	95	Coarse grain
6	60.64	1.02	....	As cast	44,400	17,100	14	16.8	5	161	98	Through the grain
				Rolled	56,900	17,100	28.0	....	5.62	164	102	Through the grain
				Drawn	69,000	57,700	16.0	46.5	3.40	176	146	Through the grain
				Annealed	52,100	17,900	28.0	23.3	7.1	151	104	Through the grain
				Quenched at 600 deg. C.	63,400	29,300	41.0	53.7	11.5	143	116	Through the grain
				Quenched at 800 deg. C.	54,000	38,800	7.0	10.1	7.1	162	155	Coarse grain
7	60.50	1.23	....	As cast	49,000	17,900	17.0	19.4	5.6	157	106	Through the grain
				Rolled	52,100	14,200	18.0	....	3.7	170	104	Through the grain
				Drawn	67,200	61,600	10.0	....	2.5	176	140	Through the grain
				Annealed	46,300	18,900	16.0	14.2	6.5	153	97	Through the grain
				Quenched at 600 deg. C.	63,400	28,500	39.0	53.7	10.3	152	118	Through the grain
				Quenched at 800 deg. C.	49,200	37,800	4.0	4.5	5.9	159	153	Coarse grain
8	61.57	3.01	....	Annealed	19,300	?	0	0	1	180	116	Coarse grain
				Quenched at 650 deg. C.	28,000	?	1.4	0	8.2	160	130	Coarse grain
9	61.12	4.89	....	Annealed	12,100	?	0	0	1	180	150	Coarse grain
				Quenched at 650 deg. C.	15,900	?	1.4	0	2.5	160	143	Coarse grain
				B. Pure Alloys. High Copper Content								
10	67.61	1.53	....	Cast and annealed	22,300	9,000	21.0	18.1	12	12.5	63	Coarse grain
				Cast and quenched at 650 deg. C.	18,500	9,000	22.0	?	3	....	58	Coarse grain
12	80.23	3.13	....	Cast and annealed	35,000	10,400	55.0	48.0	17	Bent	63	Coarse grain
				Cast and quenched at 650 deg. C.	13,200	8,200	12.0	....	11.5	Bent	60	Physical defects
				C. Commercial Alloys								
13	59.38	0.0	1.88	Rolled	63,200	26,000	27	26.4	7.5	160	107	.....
				Drawn	71,100	61,500	17.0	42.2	5.6	172	142	.....
				Annealed	55,500	?	42.5	47.6	11.3	140	94	.....
				Quenched at 600 deg. C.	64,600	?	40.5	46.5	8.6	159	112	.....
14	58.80	0.63	1.70	Rolled	67,400	24,200	28.5	28.3	9.4	158	121	.....
				Drawn	73,100	50,900	20.5	36.6	5.6	170	147	.....
				Annealed	60,000	?	32.0	34.3	8.1	158	100	.....
				Quenched at 600 deg. C.	67,400	?	30.5	42.2	8.8	160	117	.....
15	59.13	1.12	1.78	Rolled	66,900	28,400	14.5	18.1	6.3	170	130	.....
				Drawn	79,700	58,200	9	24.6	5.6	177	157	.....
				Annealed	55,200	24,600	15	16.8	6.2	163	112	.....
				Quenched at 600 deg. C.	70,300	31,500	36	40	8.1	163	125	.....
16	58.98	0.31	2.74	Rolled	60,600	28,400	23.5	24.6	6.3	165	107	.....
				Drawn	69,200	58,200	22	37.7	4.4	173	136	.....
				Annealed	54,800	?	40.5	28.3	10.0	143	92	.....
				Quenched at 600 deg. C.	61,700	?	36.5	33	8.1	158	106	.....
17	59.12	0.76	2.58	Rolled	59,200	26,000	18	20.7	6.3	115	109	.....
				Drawn	72,500	60,600	6.5	10.1	4.4	176	147	.....
				Annealed	53,600	?	24.0	24.6	7.2	158	95	.....
				Quenched at 600 deg. C.	63,200	?	35.0	45.5	7.5	158	113	.....
18	58.90	1.18	2.72	Rolled	61,700	28,400	10.5	15.5	5	174	125	.....
				Drawn	74,000	52,000	9	23.3	3.8	176	155	.....
				Annealed	49,400	19,000	11.5	15.5	5.6	166	104	.....
				Quenched at 600 deg. C.	69,400	30,400	37.5	40.7	7.5	162	120	.....



FIGS. 11 TO 16. PHYSICAL PROPERTIES OF TIN-BRASSES. ALLOYS 1 TO 7

Fig. 11. Physical properties of cast tin-brass containing 60 per cent Cu.

Fig. 12. Physical properties of tin-brass rolled and quenched at 600 deg. C. (60 per cent Cu).

Fig. 13. Physical properties of cast tin-brass, quenched at 600 deg. C. (60 per cent Cu).

Fig. 14. Physical properties of rolled tin-brass (60 per cent Cu), quenched at 800 deg. C.

Fig. 15. Physical properties of drawn tin-brass containing 60 per cent Cu.

Fig. 16. Physical properties of rolled and annealed tin-brass (60 per cent Cu).

when quenched, appear as ordinary brass. If it contains some δ this special constituent goes into solution at elevated temperatures, and after quenching at 600 deg. C. has disappeared. This is well shown in the photomicrographs, Figs. 9 and 10.

After quenching from 800 deg. C. there is a recurrence of a little α plus β at the boundaries of the α grains, as has already been remarked. But if alloys containing a large amount of tin such as shown in Figs. 7 and 8 are examined after quenching at 650 deg. C., it will be seen that the eutectoid has disappeared, δ having gone into solution, leaving only a white uniform constituent. Brass with 67.6 per cent Cu and 1.5 per cent Sn shows this phenomenon very clearly in Fig. 10; there is a little δ in the annealed metal, but after quenching at 650 deg. C., a white region may be observed, replacing the former eutectoid.

In conclusion it may be affirmed that the δ constituent is due to the presence of tin, and even if not identical it is allied to the δ constituent of bronzes. Both disappear after quenching under the same conditions.

Mechanical Tests

All the results of mechanical tests are collected in Table VII, where the history of the test-pieces is briefly noted. Tension tests were performed upon a test-piece with diameter of 13.8 mm., 100 mm. in length. An autographic Amsler machine was used at a velocity of 1 mm. in 10 seconds. Impact tests were made with a rotating hammer, having a velocity at impact of 8.6 m. Test pieces were of the Mesnager type, 10 x 10 mm., notched 2 x 2 mm. with round bottom. Brinell hardness was tested by 20 seconds' loading.

Results obtained upon the pure alloys are assembled

in a series of curves, Figs. 11 to 16 inclusive, each graph representing a given physical condition.

From the curves and tables some interesting general conclusions may be drawn:

1. In rolled and annealed samples (Fig. 16), tin increases the ultimate strength slightly up to 0.8 per cent; affects the elastic limit but slightly; reduces the elongation, reduction of area and resilience, especially above 0.8 per cent Sn; and increases the hardness a little without making the alloys less readily machined or punched. The latter conclusion is at variance with common report, but is in conformity with the author's previous investigations.

2. Quenching the rolled bars at 800 deg. C. greatly increases the hardness (Fig. 14), but gives very bad results as to ductility and resilience.

3. Quenching at 600 deg. very slightly hardens brass formed of α and β without the δ constituent. The alloys containing the latter are improved in a truly remarkable manner, as is shown by the figures obtained with all alloys containing at least 1 per cent of tin. Graphs 11 and 13 should be compared. It will be seen that the average ultimate strength is increased from 50,000 to 64,000 lb. per square inch, the elastic limit from 17,000 to 28,400 lb. per square inch, the reduction of area from 40 to 60, the resilience from 12 to 16 and the hardness from 95 to 105. Such improvement is even more clearly marked in industrial alloys, especially alloy 18.

4. Alloy 10, containing 67 per cent copper, is not improved by quenching from 650 deg. C.; a white constituent still persists in the microstructure.

5. Comparing rolled and drawn products in Table VII and Fig. 15 to Figs. 12 and 14, it will be seen that cold work and quenching produces entirely different changes in the physical properties.

6. Finally, comparing alloy 1, containing no tin, and alloy 7, containing considerable tin, it is immediately apparent that the added element has a profound effect on the results obtained after heat-treatment.

Conclusions

First, these investigations emphasize that the part played by tin in brasses is not as injurious to the mechanical properties as is generally thought, at least when it does not exceed 1 per cent.

Next, attention is called to the remarkable action of quenching, which suppresses a hard and brittle constituent (very closely related to the δ constituent of the bronzes, if not identical with it) and considerably improves all the qualities revealed by mechanical tests.

Third, brasses with 60 per cent Cu containing 1 to 2 per cent of tin are less notable in the drawn or rolled state, apart from their known non-corrosive property, but they are very interesting in the quenched state.

Location of Electric Power Stations Shown on New Series of Maps

Manufacturers interested in the location of plants within reach of electric power will welcome the series of maps now in preparation by the United States Geological Survey, showing the location of power stations and electrical transmission lines used by public utilities.

The first of the series is a map of New York State, 64 in. long and 45 in. wide, scale 1 : 500,000, copies of which may be obtained for $1 each from the Director, United States Geological Survey, Washington.

Reforestation of France

Before the war France possessed approximately 185,000,000 acres of productive forests. The bulk of these forests, about 177,000,000 acres, was in private ownership, while 3,000,000 acres was owned by the state, and 5,000,000 acres by the communes.

The war wrought great havoc with the French forests. Large areas were totally destroyed through fire, while the forests back of the fire zone were heavily drawn upon for firewood, trench timber and other necessities. After the armistice the Water and Forest Board of France, which is the national body clothed with authority over the forests and international waterways, took up the problem of reforestation. The authorities admit, however, that given the most favorable developments, it will take at least a century to bring France's forests back to their condition in 1914.

A survey after the armistice showed that in the territory occupied by the enemy 300,000 acres of state forests, 322,500 acres of parish forests and 922,000 acres of privately owned forests were subject to devastation. In over one-third of this territory the productive capacity of the forests was completely destroyed. Over half a million acres must be refitted and rewooded to make it of any use. Another area of 375,000 acres shows the effects of abusive, premeditatively destructive or wasteful fellings.

The Water and Forest Board has established a special forest reconstitution service. In each department which suffered from the invasion there has been set up a so-called "Forest Reconstruction Inspection," with definite duties relating to the restoration of the forests.

Corrosive Action of Soil on Pipes to Be Studied

The Bureau of Standards has recently undertaken an extensive investigation of the corrosive action of soil on pipes used for gas and water mains and services. In this investigation the bureau has the co-operation of the Bureau of Soils of the Department of Agriculture, the pipe manufacturers and the public utilities through the Research Sub-Committee of the American Committee on Electrolysis. Forty locations have been selected as representative of the principal families of soils to be found throughout the United States and in them will be buried a number of samples of every kind of iron and steel pipe in commercial use. Some of the samples will be uncovered and examined from time to time to determine the rate of corrosion.

Complete data on the physical and chemical properties of the soil will be obtained, also the chemical analyses of the pipe, their microstructure and complete metallurgical heating will be determined. Extensive laboratory experiments will be conducted to determine the effects of variations in individual characteristics of both soils and pipe materials. Some tests of representative pipe coatings will also be undertaken.

The results of the tests should be of great value in determining the importance of soil corrosion and in selecting the kind of pipe best suited for use in any particular soil.

It is expected that a good deal of data as to the relative rates of corrosion of different kinds of pipes in the soils under observation will be obtained within two or three years, but the experiment will probably continue over a period of eight or ten years.

Progress reports will be published from time to time as developments warrant.

Uses for Industrial Enameled Equipment*

Nature of the Field—Properties of Enameled Linings Compared With Metals—Industries Preparing Food Products Are Large Users—Chemical and Pharmaceutical Manufacturers Employ Glass-Lined Apparatus—Considerable Work Ahead in Developing New Applications in Industry

BY MAX DONAUER
Chemical Engineer, Elyria Enameled Products Co., Elyria, Ohio

ENAMELED apparatus has long ago proved its usefulness, but the field of its possibilities is far from being fully explored. Indeed, each new problem solved points to another opportunity still more interesting. And since every achievement invites another, perhaps a review of some of the fields of industrial enameled equipment may point to newer and still greater possibilities.

Types of Equipment.—Glass-enameled units for manufacturing purposes may range in size from 25 gal. to 7,500 gal., 100 gal. to 1,000 gal. covering the average limits of variation. The weight of materials handled and also the problems involved in processing them demand apparatus of rugged construction, enamel lined on the inside only. Manufacturing processes usually are planned for continuous operation of one kind, which must be carried out as economically as possible. These conditions require building and perfecting apparatus for many varied types of industrial processes.

Enameled units may therefore be fundamentally alike and yet have certain variations which make each adaptable for only one purpose. With kitchenware, lamp fixtures and similar articles, this may not be the case, but the enamel lining is an important feature whatever the actual application.

Classes of Use.—In spite of the varied requirements which manufacturing processes demand, enameled apparatus may be advantageously grouped, according to use, into three general classes, depending on whether they are for food, pharmaceutical or chemical purposes: For food work perhaps sanitation is paramount; for pharmaceutical preparations probably freedom from contamination, and for chemical uses possibly acid resistance is the chief requirement. But the list of demands made in each case is much longer and it may be interesting to examine a little more closely the requirements of a manufacturer and whether or not enameled equipment meets them or has any advantages or disadvantages which might influence the user of industrial equipment.

Points Considered When Purchasing Equipment.—A commercial piece of apparatus is purchased as an investment, and as such is judged according to points similar to the following: (1) Cost—first cost and upkeep, (2) delivery, (3) life of equipment, (4) ease of repairing, (5) producing capacity, (6) operating requirements, (7) kind of labor required for operation, (8) value of the salvage, etc. How each particular type of equipment ranks according to such a list depends somewhat on the viewpoint of the purchaser. Suffice it to say the manufacture or repair of enameled apparatus is specialized work which can be done only at a factory equipped for that purpose. However, the completed unit has a very long life, no upkeep and requires a minimum of labor for operation. An enameled unit occupies little floor space and yet has a large operating capacity. Such points as these and many similar facts prove that the use of enameled equipment is very economical.

Of all the things that a manufacturer prides himself upon, nothing ranks higher than the reputation of his product. He does everything to improve it and to produce a better product than his competitor. It is generally conceded that it is better to handle pure products in glass-lined rather than in metallic containers. The users of equipment know its advantages and shortcomings better than anyone else and their experience has pointed out interesting features concerning various types of equipment.

PROPERTIES OF ENAMELED EQUIPMENT

Fundamental Advantages of Enameled Equipment.—Enameled apparatus is easily cleaned and made sanitary. It presents a container with an inert and tasteless lining which does not discolor food products, nor is its own color changed. When cooling food products in enameled equipment, there are no adhering incrustations which cannot be easily removed. In metallic equipment these incrustations cannot be loosened without considerable scouring and if not removed become breeding places for bacteria. Enameled steel transmits heat more slowly than metals. While heating, this slowness can usually be overcome by a higher thermal head. The slower heat transmission, however, permits obtaining more uniform temperatures, and sometimes steam can be employed without local overheating under conditions in which metallic equipment requires the use of cumbersome methods of hot-water circulation. To hasten cooling is a more difficult problem. Cooled products introduced into enameled containers, however, can be stored at cold temperatures for considerable periods of time.

Comparison of Glass-Lined and Metallic Units.—There is also the problem of the presence of a metallic or a glass lining itself. All commercial metals and alloys such as aluminum, tin, copper, bronze and Monel metal are affected somewhat by weak organic acids. Some of the compounds formed when these metals

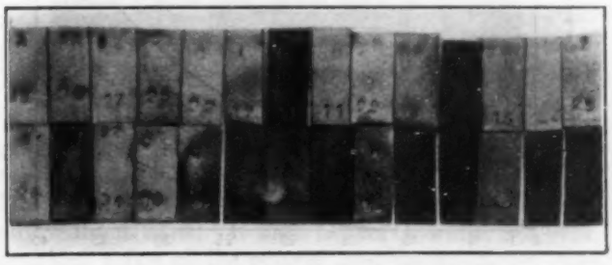


FIG. 1. ACTION OF MILK ON METALS

*Paper presented in abstract before the American Ceramic Society Annual Meeting, Columbus, Ohio, 1921.

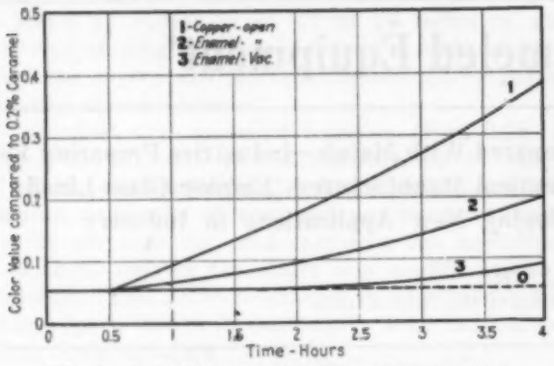


FIG. 2. DISCOLORATION OF LIGHT GRAPE JUICE CONCENTRATION

dissolve have strong metallic flavors, while others are rather tasteless. But such metallic compounds all tend to break up emulsions, to coagulate or bleach coloring matter and increase decomposition tendencies. It is interesting to note in this connection that sour cream while being made into butter will remove the tin lining in a processing vat in one week, and it has almost as vigorous an action on copper. Grape juice during vacuum concentration removes silver plating from a copper vacuum pan in a month's time.

As indicating in a general way the tendency for metals to corrode in contact with milk, Fig. 1 is shown.

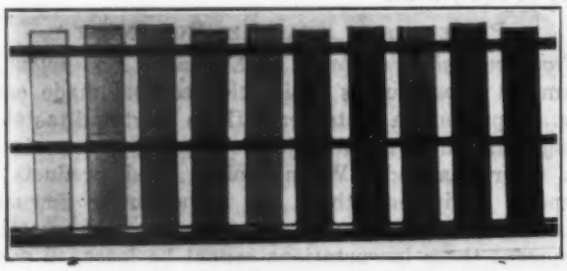


FIG. 3. DISCOLORATION OF COTTONSEED OIL ON HEATING
Order of tubes, left to right: Unmarked, E-1, C-1, S-1, E-2, C-2, S-2, E-3, C-3, S-3

The upper row of strips shows various metals which had not been immersed in milk, while the lower row shows strips of the same metals which have been immersed in milk at pasteurizing temperature for 24 hours. Of particular interest is the fact that the first metal, aluminum, did not materially discolor but was nevertheless corroded. Monel metal discolored very definitely as did zinc. Tin discolored somewhat and was very definitely pitted.

Silver in contact with fruit juices turns black in a few days. In fact, most metals turn black when used for processing foods unless they are continually scoured. Aluminum is very easily affected by weak organic acids. The products of corrosion have little taste, but their coagulating tendency and the bleaching effect during processing are well known. Copper is also acted upon by many compounds and the resulting products are exceedingly bitter. An average grade of pie filling when prepared in copper utensils dissolves enough copper to permit its being detected in the product by ordinary analytical methods.

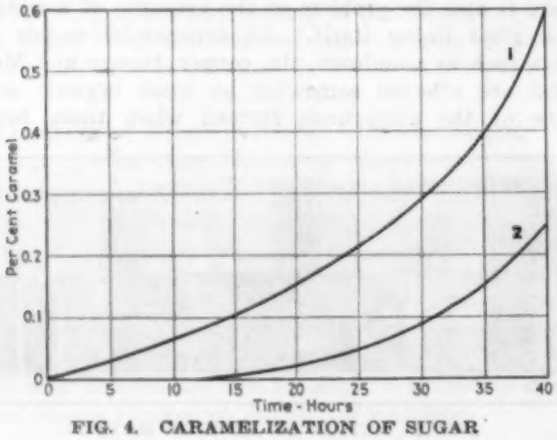


FIG. 4. CARAMELIZATION OF SUGAR

As indicative of the action of metals in producing color variations in fruit juices, a series of concentrations of light grape juice has been made under varying

FIG. 5. BEVERAGE INSTALLATION

conditions and the change in color noted by comparison with standard caramel solution. The results are shown in Fig. 2. The heating conditions in curves 1 and 2 were identical, the evaporation in one case being carried out in a copper unit and in the other in an enameled unit. The same degree of concentration in an enameled unit under vacuum has resulted in a much less marked change in color, as will be noted in curve

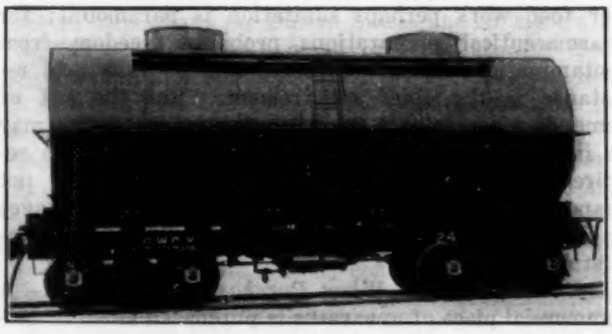


FIG. 6. FRUIT JUICE TRANSPORTATION CAR

3. The dotted line at *O* indicates the original color of grape juice in terms of the standard caramel solution.

When iron equipment is used for refining oils, the product first prepared turns out dark yellow. Gradually the iron is covered with a crust of oxidized oil which lessens the discoloring. With enameled equipment, a glass lining, instead of a burned-on crust, is used to protect the oil. Oils do not form crusts on enamel. Similar differences are noted in other processes.

The tendency for vegetable oils to discolor when being heated in contact with metal is evident in Fig. 3, which

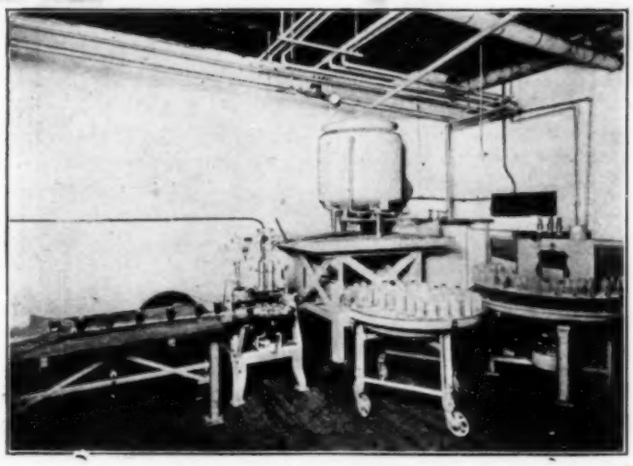


FIG. 7. JAM FILLING TANK

shows a series of tests on cottonseed oil under uniform conditions of heating, but in contact with enamel, copper and steel. The unmarked tube at the left indicates the intensity of color in the unheated oil. The oil in the tubes *E*-1, *C*-1 and *S*-1 were heated for a given time in contact with enamel, copper and steel. The oil in tubes *E*-2, *C*-2 and *S*-2 was heated for twice the period of time and that in tubes *E*-3, *C*-3 and *S*-3 for three times the period of time. It will be noted that in each case the change in color of the oil heated in contact with copper and steel is much more marked than that heated in contact with enamel. It should be noted that the differences in color intensity indicated in this figure are far from being as positive as in

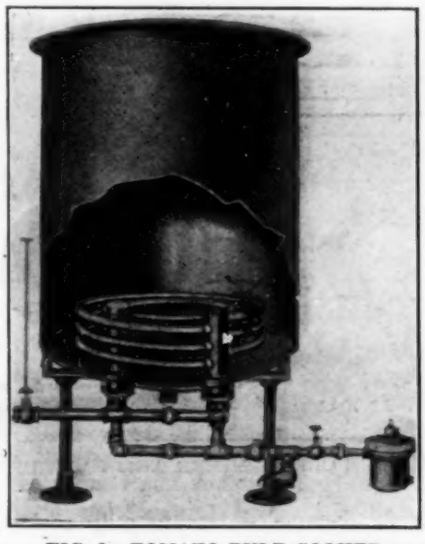


FIG. 8. TOMATO PULP COOKER

the actual samples observed by the eye, due to the extreme difficulty of registering differences in intensity of yellow by means of the photographic plate.

There are other reasons for using enameled equipment which are advantages that are inherent to the glass lining itself. Fats do not readily become rancid when heated in enameled containers, while they do turn rancid before long when heated in any metallic container. Caramelization of sugars is much slower in enamel than in metallic vessels and this considering the same amount of evaporation or other heating being accomplished when making the comparison. As can readily be seen, this permits obtaining lighter color in many varieties of manufactured food products. With some of the more acid foods, on the other hand, metals have a considerable bleaching effect, tending to destroy the rich natural colors and producing uninviting caramel-like colors and tastes.

The relative effects of copper and enamel in promoting caramelization in hot cane cugar sirup is indicated in Fig. 4. Curve 1 indicates the discoloration produced by various periods of heating in contact with copper, whereas curve 2 indicates the color change when heated in contact with enamel. The heating conditions were such that the same amount of heat was being transferred per unit area in the two cases.

Still another field where enameled equipment presents its advantages is in the manufacture of pharmaceutical and chemical products. Here the acid-resistant types of enameled ware offer great advantages. In many cases

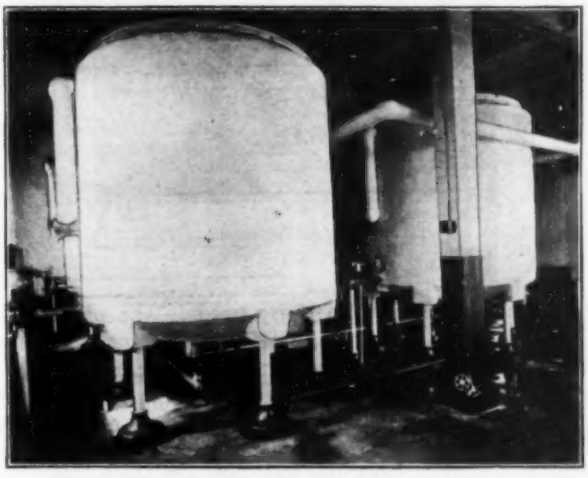


FIG. 9. WHOLE MILK STORAGE TANKS

the glass lining, in preventing metallic contamination, avoids the necessity of special purification of the products. For some operations metallic equipment can be used if certain strengths of acids are maintained, but rarely do these concentrations permit the largest yields. With acid-resistant glass-lined units, concentrations of acids to permit the largest output can always be employed. Many chemical processes involve strong acid reactions which can be carried out successfully only

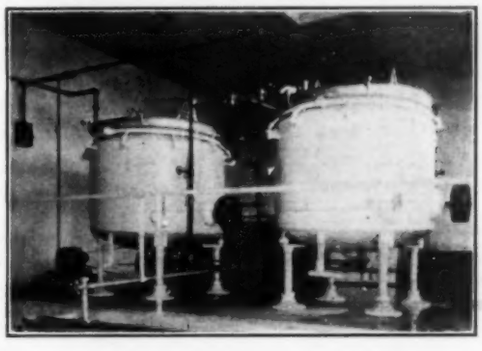


FIG. 10. PASTEURIZING VATS

in glass or acid-resistant enamel, and in such cases the ruggedness and strength of enameled units make the latter far superior.

The variety of uses for enameled equipment is practically without limit. It may be worth while, however, to consider a few of the typical uses for enameled ware and why it is well adapted for such uses.

Glass-Lined Beverage Equipment.—Enameled equipment has become a standard material for the manufacture of beverage sirups. The flavors are extracted, compounded and colored in steam-heated kettles. Sugar sirups are prepared by dissolving sugar in water and the resulting sirups are then blended with the various flavoring materials. The finished product is frequently held in large enameled storage tanks which supply the bottling machines. The same units are used interchangeably for making many varieties of sirups.

Enameled Units for Flavoring Extracts.—The manufacture of some types of flavoring extracts involves

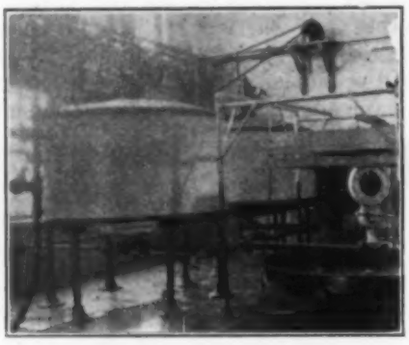


FIG. 11. CONDENSED MILK STANDARDIZERS

processes very similar to those used in the preparation of beverage sirups. Orange or lemon extracts and similar products are manufactured by dissolving the flavoring oils in alcohol and storing in airtight enameled tanks. Vanilla extracts are obtained by alcoholic extraction of vanilla beans. Enameled percolators are used in both the hot and cold processes. The finished product is bottled frequently with the aid of enameled filling tanks. When non-alcoholic extracts are made, the extract liquor is concentrated in glass-lined vacuum pans, the vanilla solids being held in solution by glycerine. Recently various non-alcoholic flavoring emulsions have been put on the market. These are usually essential oils emulsified with vegetable gums. Enameled mixing machines are frequently used, because they permit obtaining lighter colored emulsions.

Fruit Juice Equipment.—Glass-lined equipment has been found very adaptable in the manufacture of fruit juices. Fruits such as loganberries, grapes, etc., are preheated in jacketed enameled kettles. After pressing, the juice is held in horizontal storage tanks to permit particles of fruit pulp to settle out. Jacketed enameled kettles are then used for pasteurizing the product before bottling.

Enameled Jam and Jelly Kettles.—The preparation

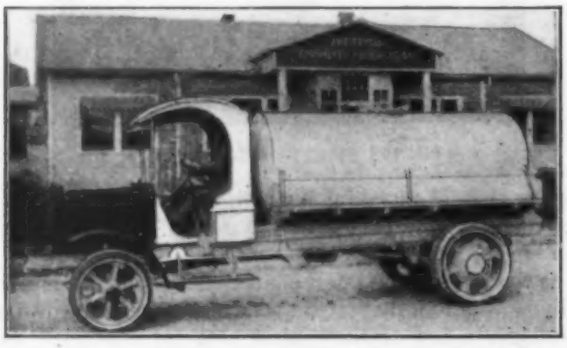


FIG. 12. MILK TRANSPORTATION TRUCK

FIG. 13. MILK TRANSPORTATION CAR

of fruit juices for making jellies involves a very similar procedure. The juice, after being clarified by settling in a horizontal storage tank, is boiled up with an equal volume of sugar, and, when concentrated to the proper consistency, is run immediately into an enameled jam cooler, where it is cooled to stop any further loss of color before bottling. It has been found that a better flavored and richer colored product is obtained if jellies are concentrated under vacuum in enameled vacuum pans built for that purpose. The vacuum system also eliminates the necessity of having a jam cooler.

Enameled Equipment in the Tomato Industry.—A better color and flavor are the aim of manufacturers of food products. Many types of industrial equipment do not produce as good a finished article as that which the housewife can obtain using small utensils, and naturally she considers the value of the products by the comparison. The tomato industry illustrates very well the advantages which enameled equipment possesses, when the improvement in color and flavor, which it permits,

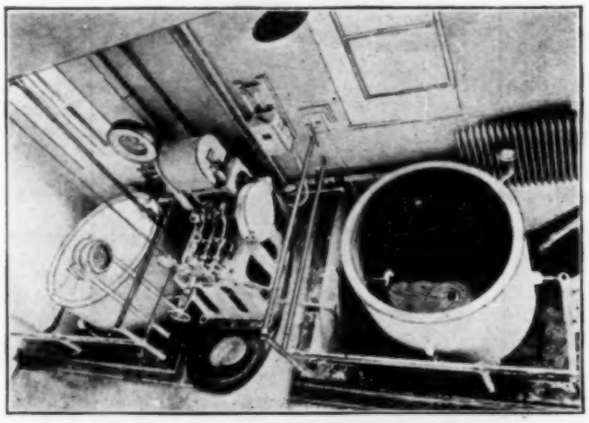


FIG. 14. ICE CREAM MIXER AND PASTEURIZER

is considered. Enameled tomato pulp cookers are in very common use for concentrating tomato pulp. The finished pulp is stored in large enameled storage tanks, being held until converted into tomato paste or various tomato products such as are used for making purée, catsups, etc. The problem of keeping the enameled units clean is very simple. Records, kept over long periods of time, show that the products manufactured have a much lower bacteria count than those made in other equipment.

Enameled Equipment in the Milk Products Industries.—In the milk and milk products industry sanitation and freedom from metallic flavors must receive greater consideration than in most other food industries. For such work enameled equipment has found great favor. Rectangular vats are used for receiving and weighing

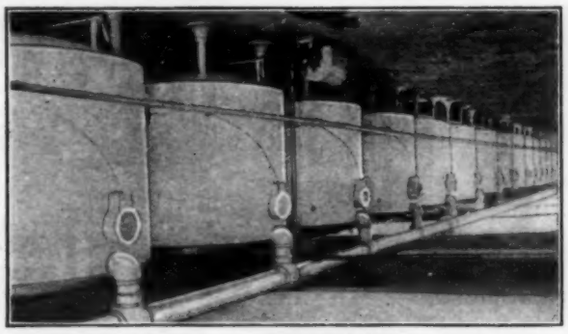


FIG. 15. CREAM AGING TANK

the milk as it comes from the farmer. From these vats the raw milk is pumped over tubular coolers and into closed enameled tanks equipped with brine-cooled jackets. The milk is pasteurized in steam-heated enameled vats and then cooled and bottled. In the condensed milk industry the milk is received and held in similar manner. It is preheated in enameled hot wells and after being concentrated in vacuum pans is run into large enameled standardizing and storing tanks, where the entire day's output is mixed to a uniform blend. Enameled motor trucks and tank cars are now replacing cans for collecting milk and bringing it to central receiving stations. Usually ice cream is made by mixing condensed or powdered milk, butter, sugar and other ingredients in steam-jacketed enameled tanks. The mixture is pasteurized in the same apparatus and is immediately homogenized. It is then aged several days in enameled aging tanks to improve its flavor and texture. Enameled units are also available for neutralizing and ripening cream for butter manufacture and for preparing starters to produce proper flavors during this ripening. Enamelel vats are used in preparing cheese, churning oleomargarines and nut butters with ripened milk, rendering lard for oleomargarines, and in many other like operations.

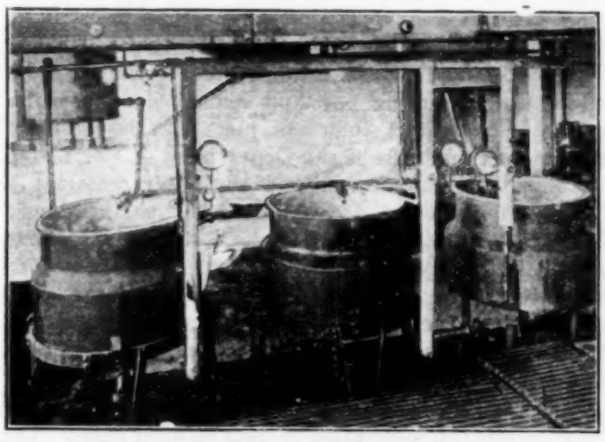


FIG. 16. MINCE MEAT COOKERS

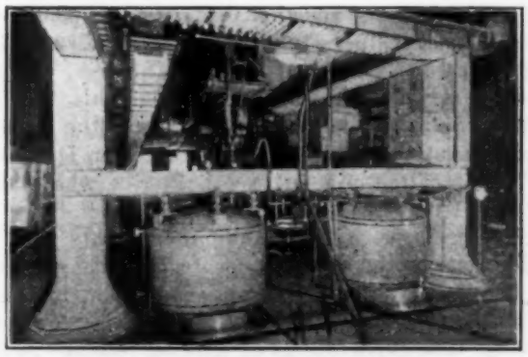


FIG. 19. PHARMACEUTICAL MIXING AND FILLING TANKS

Applications in Other Food Industries.—The list of processes where enameled equipment is used, not only because it is applicable but mainly because it has many advantages, is far from being exhausted. In many food industries such as the manufacture of gelatine, invert sugar, mince meat, the blending of honey, making prepared mustard, refining edible oils, mixing salad dressing, cooking tomato catsup and pasteurizing vinegar, enameled equipment is now used. Time is not available for describing many possible applications. There are still a few uses of different types which merit mention.

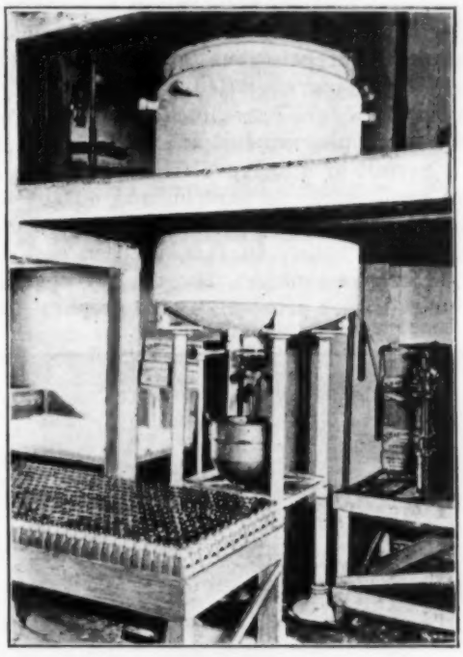


FIG. 17. SALAD DRESSING FILLER

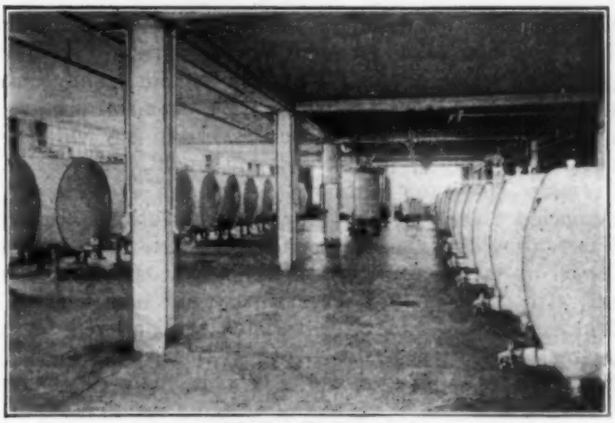


FIG. 18. PHARMACEUTICAL STORAGE TANK

Enameled Equipment for Pharmaceutical Purposes.—One would naturally expect manufacturers of pharmaceutical products to equip their factories quite extensively with enameled apparatus, and such is the case. Enameled equipment has been successfully applied in the manufacture of cod liver oil emulsion, camphor ointment and similar emulsions. Alcoholic soap for

tooth pastes is prepared in closed enameled tanks and the various ingredients, such as glycerine, flavoring oils and chalk, are incorporated using the same apparatus. Numerous varieties of sirups, elixirs, antiseptics and medicines are mixed in enameled tanks and held in storage in other closed tanks until ready for use. The mixing of face creams, evaporation of metallic citrates, extraction of alkaloids, preparation of synthetics such as barbitol, veronal, dichloramine T and many other pharmaceutical preparations are carried out advantageously employing enameled equipment.

Chemical Uses for Glass-Lined Equipment.—The difference between pharmaceutical and chemical operations does not permit of a sharp division. On one hand we have the preparation of aspirin, and on the other the evaporation of thorium nitrates. Enameled equipment is applicable to both. In fact, in each case indicated it is practically essential. The field of chemical operations involves such problems as the preparation of pure

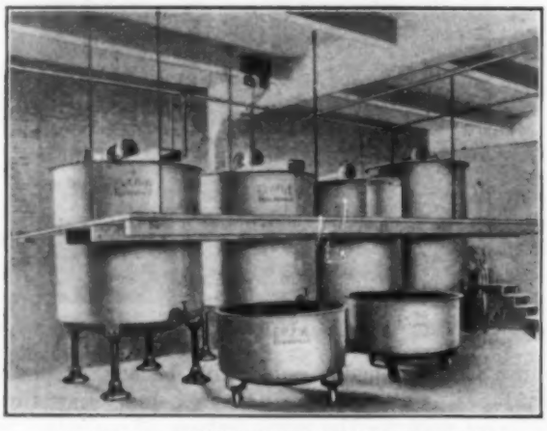


FIG. 20. TANKS USED IN PREPARING SYNTHETIC DRUGS

inorganic salts by evaporation, the distillation of compounds such as acetic anhydride or the chlorination of aromatic compounds. In each, enameled evaporating dishes, stills or reaction kettles are very applicable. In fact their use frequently eliminates purification processes which other types of equipment usually make necessary, and there are many other chemical processes eventually connecting with our everyday life which are carried out using glass-lined equipment. Rare earth bromides used for luminous paints are evaporated in enameled dishes. Platinum chloride solutions are similarly processed before refining. Tartaric acid and cream of tartar for use in baking powders are boiled up with charcoal and crystallized in enameled pans. Many dyestuffs and intermediates are prepared using enameled reaction kettles. And so the list goes on, but the above examples are perhaps more than sufficient.

A Broad Future

Enameled equipment has not been applied to all industrial processes with their varied demands. In some cases its use is rather recent. Often the manufacturer, searching for the best, has tried enameled equipment for his purpose with marked success. A great many possibilities still remain untried. The uses to which enameled equipment has been applied have pointed out that it has certain advantages which may be improvements in any process and have also pointed out an occasional drawback for its application. Being familiar with some of the various types of work wherein it is

FIG. 21. JACKETED EVAPORATING DISHES

successfully used, new uses may suggest themselves and their possibilities be considered by comparison. If the preceding notes have, in such a way, pointed out the nature of the field of enameled equipment, then their purpose has more than been accomplished.

Cement Specifications for Foreign Countries

The specifications that the various countries of the world use in buying portland cement have been summarized in a chart that has just been issued by the Bureau of Standards of the Department of Commerce.

Cement is an international building material and thirty-two countries of the world have specifications for portland cement, twenty of which differ in important details. Twenty-five others use the specifications of other countries in assuring the quality of the cement used in construction within the country, and many others accept the cement if it passes the tests of the country in which it is made.

Though the specifications differ in details and values, they include the same kind of tests in most cases. These are tests for chemical composition, specific gravity, fineness of grinding, setting time, soundness, and tensile and compressive strength.

In this country, there is one universal specification for portland cement, which has been adopted by the commercial interests and testing engineers as well as the Government.

Italian Olive Oil Industry

In 1918 583,600 hectares was cultivated exclusively with the olive tree, and 1,711,100 hectares with this tree and other plants, the total production of olives reaching 17,244,000 quintals, and that of olive oil 2,800,000 hectoliters. The greatest production of olive oil was in the Puglia region; then came Sicily, Calabria, Campania, Tuscany, Abruzzi, Lazio, Umbria, Sardinia, Basilicata, Liguria, Marche, Emilia, Lombardia and the Veneto.

At present the most important region in Italy for the production of the olive oil tree is Puglia, where 300,000 hectares is cultivated exclusively with it, and about 200,000 hectares with it and other plants. In other Italian regions the hectares devoted to olive tree culture are much below such figures. Piedmont is the only region that does not produce olive oil, owing to its colder climate. The exportations of olive oil (edible) increased during the first six months of this year, reaching 1,394 tons, against 798 tons during the same time last year.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

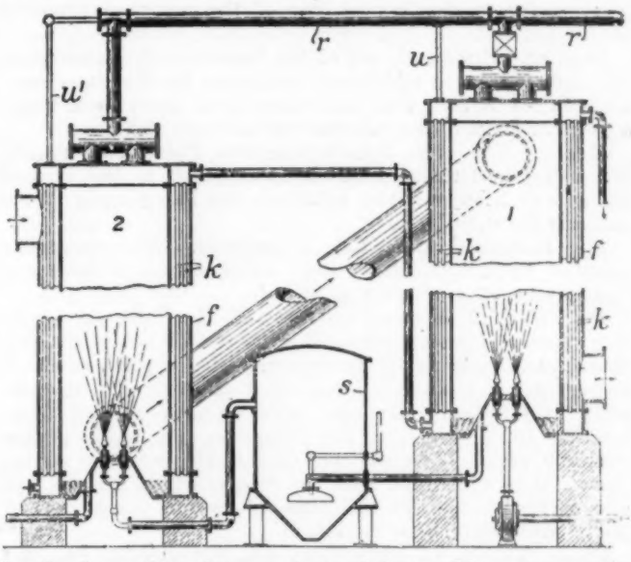
Polymerizing Fatty Acids.—Unsaturated fatty acids to be polymerized are converted into alkali salts free from glycerine, and these salts are boiled with caustic lyes, such as caustic soda of 10-12 deg. Bé., to settle out albuminous and other impurities, precipitated out with common salt, heated in an autoclave at 180-214 deg. C. for at least 3 hours, afterward concentrated at constant pressure until the soap contains at least 75 per cent of fatty acids, and then heated in the closed autoclave at 180-214 deg. C. until the desired degree of polymerization is obtained. The purification of the alkali salts admits of lower temperatures being employed so that fish oils, refuse oils, and other impure oils can be treated satisfactorily. (Br. Pat. 166,236. De Nordiske Fabriker De-No-Fa Aktiesalskap, Christiania. Sept. 7, 1921.)

Amino Compounds.—Amino compounds are prepared by passing nitro compounds such as nitrobenzene and nitrotoluene, in the vapor phase and together with hydrogen, water gas, etc., over or in contact with a copper-containing catalyst. In place of hydrogen as such there may be employed a body such as secondary butyl alcohol, which is capable of being dehydrogenated under the conditions suitable for the reduction of the nitro compounds, in which case there is obtained in addition to the amino compound, methyl ethyl ketone, or, if methyl alcohol is employed, the reaction product of formaldehyde and aniline. The copper-containing catalyst in a dense porous condition is produced by fusing cupric oxide, cooling it and breaking it into pieces; if desired, the mass may be wholly or partly reduced in a current of hydrogen after the cooling stage. Instead of cupric oxide, a copper salt, such as the nitrate or carbonate, capable of producing cupric oxide on heating, may be used as starting material. The catalyst can be revivified by heating in air to temperatures between 300 and 1,000 deg. C. (Br. Pat. 166,283. D. A. Legg and M. A. Adam, both of London. Sept. 7, 1921.)

Dyes Derived From Anthracene.—Vat dyes are obtained by heating 2-aminoanthraquinone with caustic potash in the presence of a non-hydroxylic diluent or solvent—for example aniline, naphthalene, liquid paraffine or toluene; temperatures of 180-250 deg. C. are suitable. According to examples: An impure 1:2:2^1:1^1-N-dihydroanthraquinoneazine dyeing green shades is obtained by boiling 2-aminoanthraquinone with aniline and caustic potash; a pure 1:2:2^1:1^1-N-dihydroanthraquinoneazine dyeing blue shades is obtained by boiling 2-aminoanthraquinone with naphthalene, caustic potash, and potassium nitrate. (Br. Pat. 166,297. F. W. Atack, Manchester, and J. Anderson, St. Andrews, Fifeshire. Sept. 7, 1921.)

Cellulose Ethers.—Cellulose derivatives, suitable for the same or similar applications to the known cellulose ethers and esters, are prepared by reacting on cellulose or its conversion products with halogen esters of glycols or of polyhydric alcohols, or of their ethers—for example, ethylene or propylene chloride or chlorhydrin, glyceryl chlorhydrins, epichlorhydrin and monochlorether; if the ester contains free hydroxyl groups, then such groups are retained in the resulting cellulose derivative. The reaction is carried out in the presence of basic substances, preferably caustic alkalis, and it is preferred to start with cellulose or a conversion product not soluble in alkali and as little depolymerized as possible; it is preferred to employ in the reaction limited quantities of water, say from no water up to four times the weight of the cellulose taken, but preferably between one-half to one and a half times such weight, and preferably a total amount of alkali as would correspond to a 50-75 per cent or even 95 per cent solution in the water present or added; usually the reaction is carried out at about ordinary temperature, and preferably with cooling to about 0 deg. C. or lower; and the reaction may be carried out with the addition of diluents or solvents such as benzene and in the presence of contact substances such as copper powder, or copper salts or hydroxides. In examples, cellulose is impregnated with 50 per cent caustic soda solution, kneaded with ethylene chlorhydrin or glyceryl monochlorhydrin while cooling to 0 deg. C., with subsequent additions of powdered caustic soda and chlorhydrin; alternatively, the cellulose may be impregnated with water and the caustic soda added in powdered form. The whole of the caustic alkali may be added prior to the treatment with halogen ester, and the ester may be incorporated all at once or in portions or continuously during the process. Mixed cellulose derivatives may be obtained by the introduction of different groups or residues of the class referred to, or by the introduction of other ether groups such as alkyl, benzyl and homologous groups. (Br. Pat. 166,767. H. Dreyfuss, London. Sept. 14, 1921.)

Distilling Ammoniacal Liquor.—Heated ammoniacal liquor is sprayed in succession into two or more evaporating chambers 1, 2, the pressure in the first chamber being utilized to effect the spraying into the second. The liquor may be passed through an intermediate chamber *s* in which it is mixed with a reagent to liberate fixed ammonia. The chambers 1, 2 are heated by flue gases circulating in jackets *f*. The ammoniacal liquor is preheated by passage through tubes *k* in the jackets. Connecting-pipes u, u^1 serve to pass the gases generated during the heating of the liquor in the tubes *k* to the collecting main *r*, which leads to a saturator



for the formation of ammonium sulphate. If pure ammonia is to be separated, the first evaporating chamber is surmounted by a column up which the vapors pass and down which a portion of cold ammoniacal liquor flows and removes ammonia from the vapors. The liquor falls through the perforated top of the spraying chamber. The liquor from the base of the chamber is passed through a vessel *s* and then in succession through spraying chambers from which ammonia gas is withdrawn. (Br. Pat. 167,719. Holmes & Co., Ltd., W. C. and M Boocock, and W. Wyld. Leeds. Oct. 5, 1921.)

Lubricants.—Lubricating oils are obtained by blowing air or oxygen through a mixture of hydrocarbon oil and a catalyst consisting of a manganese, lead or mercury compound, maintained below the cracking point of the oil and between 50 and 300 deg C. until 0.2 to 1.0 per cent fatty acid is produced. Volatile products may be permitted to escape, or any desired portion may be retained as by flowing the oil and air or oxygen in the same directon and cooling sufficiently to condense the desired portion. The product may be blended with other hydrocarbon lubricating oils, vegetable or animal oils or fats, alkali, soap or graphite. (Br. Pat. 167,789. J. Harger, Liverpool. Oct. 5, 1921.)

Current Events
in the Chemical and Metallurgical Industries

More Plants Increasing Operations

Glass. The Libbey Glass Co. has arranged production on a full 24-hour working basis at its Sandusky, Ohio, plant.

Paper. The Young & Goodfeller Paper Co., Bently Springs, Md., has resumed operations at its local Eagle Mill, following a suspension of manufacture for several months. New machinery has been installed in certain departments of the plant during the idle period.

The Whalen Pulp & Paper Co., Toronto, Ont., is prefecting plans for the early resumption of production at its paper mill in the Swanson Bay section, near Prince Rupert, B.C. Other plants of the company at Port Alice and Howe Sound are now in operation.

The Hinde & Dauch Paper Co., Sandusky, Ohio, has placed its local mills on a normal operating basis. The No. 1, main plant, is running on full time, 5½ days a week; the No. 2, or West End mill, is operating on a 6-day week schedule.

Chemical. The Davison Chemical Co., Baltimore, Md., is now operating its local plant on a basis of about 80 per cent of normal. It is stated that there is a marked increase in demand for sulphuric acid, one of the principal products of the factory.

Leather. Practically all of the tanneries at Wilmington, Del., are taking on additional employees for increased production. It is said that the larger local plants will reach a pre-war basis of manufacture at an early date.

Metals. The New Jersey Zinc Co., Palmerton, Pa., is increasing manufacture at its local plant in the line of oxides and lithopone, and additions are being made to the working force.

The Rosario Mining Co., Tegucigalpa, Honduras, has resumed operations at its local silver mines, following a curtailment of a number of months.

Tin Plate. The American Sheet & Tin Plate Co. began operations at twenty additional mills at its New Castle, Pa., plant Nov. 20, bringing production up to a point of about 90 per cent of normal; a 5-day week schedule will be operative. Operations have also been resumed on full time, working three shifts, at the Monesson, Pa., mills of the company, effecting 100 per cent or normal production at this plant. It is announced that the Shenango, Pa., works will also be resumed under full capacity, where twenty out of thirty mills have been running.

Coke. The H. C. Frick Coke Co., Uniontown, Pa., has placed 850 additional ovens in blast at its works, bringing operations up to a total of about 2,000 ovens and giving employment to approximately the same number of men. The majority of the ovens have been idle since last March and April.

The W. J. Rainey Co., Inc., is operating 150 ovens at its Mount Braddock, Pa., plant, and 100 ovens at the Elm Grove, Pa., works.

Iron and Steel. The Interstate Iron & Steel Co., Chicago, Ill., has increased production to about 50 per cent of normal at its local plant.

The American Steel Foundries Co., East St. Louis, Ill., has resumed production at its local plant, following a shutdown since last February. Employment will be given to about 800 men. The company also reopened its plant at Alliance, Ohio, Nov. 14, with a working force of about 300 men, which will be increased gradually from week to week.

The Thomas Iron Co., Alburtis, Pa., is planning to blow in its Lockridge furnace early in December.

The National Tube Co., McKeesport, Pa., has placed another furnace in blast at its local works, making three out of four furnaces now in service.

The National Malleable Castings Co., Sharon, Pa., has increased operations from 5 to 6 days a week.

Dye Investigation Not Ordered

An unsuccessful effort was made by Senator King, of Utah, during the closing hours of the extra session of Congress to obtain action on the resolution proposing to investigate the dye industry and its efforts to influence legislation. Senator King objected to the action of the Judiciary Committee in limiting the investigation to the alleged dye lobby and to the alleged existence of a dye monopoly. He said that any investigation should include a probe of the efforts made to influence the federal dye control agency and various other activities of dye interests.

Had Senator King been willing to accept an amendment by Senator Frelinghuysen, of New Jersey, that the investigation be broadened so as to allow the committee to search into the activities of importers of dyes, the probe doubtless would have been ordered. Instead, he tried to override the Frelinghuysen suggestion by demanding a vote on the measure as reported by the Judiciary Committee. The absence of a quorum was developed and a motion that the Senate adjourn *sine die* put an end to the effort.

Senator Frelinghuysen expressed the opinion that the Senate should know whether or not the importers are controlling or influencing the dye market or the trade in dyes. He said that neither the dye nor the chemical industry fears any investigation, but that something might be revealed if the practices of importers were laid bare.

Senator McCumber, of North Dakota, expressed the opinion that an investigation of the character proposed by Senator King would be of doubtful value. He said that matter already has been the subject of extended inquiry and that enough testimony has been taken to enable anyone concerned to determine "whether or not there has been such a propaganda as is supposed to influence Senators, and whether or not the dye industry is a monopoly."

Senator Moses, of New Hampshire, declared that there is a vast amount of evidence on the subject that never has been presented to a congressional committee. He declared that he personally has evidence concerning the activities of dye interests in New Hampshire which never has been revealed. Senator King added that there should be an investigation "that will investigate—that will get all the facts relating to this monopoly, its activities, its sinister purposes, its reprehensible if not corrupt methods of operation, its persistent efforts to control Congress and to secure legislation that will enable it to destroy all competition and put millions in the pockets of a favored few."

Senator Brandegee, of Connecticut, not only expressed the opinion that the investigation would amount to nothing but stated that it is not the business of Congress to determine what is and what is not a monopoly. He held that it is a judicial question for the courts to decide. "It would amount to nothing," he said, "to resolve that in our opinion the dye industry is a monopoly."

Additional Papers for the Baltimore Meeting, A.I.C.E.

The final program for the meeting of the American Institute of Chemical Engineers, which will be held in Baltimore, Dec. 6 to 9, contains four papers which were not included in the program printed in our issue of Nov. 16. L. W. Wallace, executive secretary, F.A.E.S., will address the institute at 10 a.m., Dec. 6. During the morning of Dec. 8, Prof. J. H. James will present a paper on "Some New Products From Petroleum" and Dr. Robert M. Yerkes will discuss the research information service of the National Research Council. The fourth paper, which is scheduled for 10:15 a.m., Dec. 9, is "Regenerative Evaporation," by Prof. W. L. Badger.

Program, American Petroleum Institute Meeting

As announced in a preliminary bulletin, the program of the second annual meeting of the American Petroleum Institute at the Congress Hotel, Chicago, Dec. 6, 7 and 8, will include general sessions in the afternoons and evenings, and technical sessions Tuesday and Wednesday mornings.

Among the addresses at the general sessions will be: "The Current Year in the Petroleum Industry," Walter C. Teagle, president Standard Oil Co. of New Jersey; "The Mid-Continent Refiner," D. W. Moffitt, vice-president, Cosden & Co.; "Looking Ahead," Harry F. Sinclair, chairman of board, Sinclair Consolidated Oil Corporation; "Some Things We Might Be Doing," Henry L. Doherty, president, Cities Service Co.; "As John Bull Views It," Sir John Cadman, formerly his Majesty's petroleum executive; "World Highways of Trade," A. C. Bedford, chairman of board, Standard Oil Co. of New Jersey.

The technical program is as follows:

TUESDAY, DEC. 6, 10 A. M.

General topic, "The Motor Fuel Problem."

Presiding, R. D. Benson, president, Tide Water Oil Co.

"Quantitative"

"Quantitative Survey of Petroleum Industry From the Standpoint of Production of Motor Fuel," Van H. Manning, director of research, American Petroleum Institute.

"Quantitative Survey of the Automotive Industry, Present and Prospective," Edward S. Jordan, president, Jordan Motor Car Co.

"Qualitative"

"Requirements of Motor Vehicle Fuel," H. M. Crane, engineer.

"Qualitative Limitations in Refining and Marketing," Frank A. Howard, manager, Development Department, Standard Oil Co. (New Jersey).

"Volatility of Motor Fuel as Marketed in the United States," N. A. C. Smith, petroleum chemist, U. S. Bureau of Mines.

"What Constitutes True Volatility," R. E. Wilson, director of research, Laboratory of Applied Chemistry, Massachusetts Institute of Technology.

"Present Variations in the Quality of Motor Fuel—Its Extent and Causes," C. K. Francis, chief chemist, Cosden & Co.

General discussion.

WEDNESDAY, DEC. 7, 10 A. M.

General topic, "The Motor Fuel Problem."

Presiding, Capt. J. F. Lucey, president, Lucey Manufacturing Corporation.

"Limitations Imposed on Economy by Volatility Changes," F. C. Mock, research engineer, Stromberg Motor Devices Co.

"Practical Effects of Too Low Volatility," O. C. Berry, chief engineer, Wheeler-Schebler Carburetor Co.

Thirty minutes of general discussion.

General topic, "Value of Research to the Petroleum Industry in General."

Discussion by:

David Beecroft, president, Society of Automotive Engineers; T. G. Delbridge, chief chemist, Atlantic Refining Co.; A. W. Ambrose, petroleum technologist, U. S. Bureau of Mines; K. G. Mackenzie, chief chemist, the Texas Co.; W. C. Platt, president, *National Petroleum News;* J. R. Stockton, vice-president, Producers & Refiners Corporation.

Executive Committee, Division of Chemistry and Chemical Technology, N.R.C., to Meet

The executive committee of the Division of Chemistry and Chemical Technology of the National Research Council will meet in Washington on Monday, Dec. 12, to consider the progress of investigations and the committee work which will be supported for the coming year. Any persons interested desiring to make suggestions regarding plans for the work of the division should send them before that date to Dr. F. G. Cottrell, chairman, 1701 Massachusetts Ave., Washington, D. C. Other members of the committee are: Julius Stieglitz, vice-chairman; Colin G. Fink, W. F. Hillebrand, R. B. Moore and W. D. Bancroft.

Federated American Engineering Societies to Review Progress at Annual Meeting

In a statement summarizing general conditions in the Federated American Engineering Societies, the executive secretary, L. W. Wallace, expresses the belief that the federation has made substantial progress. At the annual meeting of the American Engineering Council to be held in Washington Jan. 5 and 6, this progress will be shown by reports covering activities in many fields.

"Unquestionably," says Mr. Wallace, "the federation has made favorable and permanent contacts in Washington. Through the activities of Congress and of the new federal administration, we have had the opportunity of rendering some really constructive service. We feel, however, that the great body of engineers are not adequately informed of the organization of the federation, of its aims and purposes and of its activities.

"This lack of information is serious and until engineers in general are more fully informed, we shall not hope to function to the best advantage. The executive board should therefore give serious consideration to methods of informing engineers as to the aims, policies and activities of the federation. Some member societies have been and are now perhaps rather indifferent to a continuation of their affiliation. As far as we have been able to ascertain, this condition is due to the officials and the members of such organizations not being fully informed.

"While it may be true that during the first year the federation has not been able to accomplish all that was expected on the part of some and that it has not fully found itself, so to speak, yet the progress has been such as to justify optimism rather than pessimism as to the future usefulness of the federation. The federation has been fairly well established in the minds of the public and in Government circles. This is evidenced by the character and quantity of publicity that the federation has received.

"The report of the publicity committee to the executive board clearly shows that the activities of the federation have attracted attention and notice in all of the leading cities and many of the towns and villages of this country. Constant reference is being made to the federation in the technical, daily and periodical press of every description. It is also being referred to in the official proceedings and publications of many commercial and trade associations. This alone is one reason for encouragement."

Sectional Meetings of Steel Treaters

The American Society for Steel Treating is planning to hold sectional meetings at quarterly intervals in addition to its annual meeting and exhibit. By holding the directors' meetings at the same time, a double purpose may be served: The national officers may become acquainted with regional activities with the minimum travel, while many local members who cannot afford to attend the convention—which may be at some distance—will be able to get together for an afternoon and evening social and technical session. The first of these meetings will be held in New York City some time in March, 1921. It is hoped that it will attract the membership of chapters in Baltimore, Boston, Bridgeport, Hartford, Lehigh Valley, New Haven, Schenectady, Syracuse, Providence, Springfield, Washington and Worcester. Walter F. Graham, Truell Court, Plainfield, N. J., is in charge of the arrangements.

Muscle Shoals Deal Likely to Go Through

A definite recommendation by the Secretary of War favorable to Henry Ford's proposal to develop Muscle Shoals probably will be made to Congress shortly after the opening of the regular session. Certain details of the negotiations are not complete and have been delayed by the illness of Secretary Weeks. It is believed, however, that an agreement will be reached without difficulty, although alternative plans may be submitted to Congress.

Muscle Shoals was discussed at a meeting of the Military Affairs Committee of the House on Nov. 21. It was revealed that the committee is thoroughly in sympathy with the policy of having this water power developed by private interests.

Minerals Separation Claims 12 Millions

At the hearing before the Master in the accounting proceedings resulting from the infringement suit against the Butte & Superior Co., which was held in New York, Nov. 3 to 19, Minerals Separation presented a claim of $11,904,913.95 as representing the profits, gains and advantages which the Butte & Superior Co. had realized from its use of the Minerals Separation patented processes.

The magnitude of this amount is due to the setting up of water gravity concentration as the standard of comparison. This standard, it was testified by Minerals Separation, was the only one which was available to the Butte & Superior Co. It was also testified by Minerals Separation witnesses that 65 per cent recovery of the zinc and a 48 per cent grade of concentrate was the best result which it would have been possible to have obtained upon Butte & Superior ores by water gravity concentration. Applying the difference between this result and the results which admittedly had been obtained through the operation of the Minerals Separation patented processes over the period of years from 1913 to 1919, during which period infringement had been adjudged, the above-mentioned claim as to amount of damages was arrived at.

It would therefore seem that the amount of resulting damages resolves itself largely into a question as to the standard of comparison which may be found to be applicable. Judge Bourquin, in the United States District Court of Montana, has rendered an opinion as to the law governing the available standard of comparison (see CHEM. & MET. ENG., Sept. 7, 1921, page 484), and since this opinion is based upon a motion by Minerals Separation in this very case, the application of this opinion may have the effect of very considerably modifying the figure above given, since by this opinion the Butte & Superior would not seem to be restricted to water gravity concentration as a standard, nor if so, is it likely that the percentages given by the plaintiff will remain unchallenged in the defense which will be submitted when the hearings are resumed Feb. 14, 1922.

Meeting of Synthetic Organic Chemical Manufacturers Association

The adjourned organization meeting of the Synthetic Organic Chemical Manufacturers Association was held Nov. 18 in the Pennsylvania Hotel, New York City. A large and representative attendance was present. During the meeting there were added to the membership by election thirteen active members and one associate member.

W. S. Cashman of the Grasselli Chemical Co., Cleveland, Ohio, was elected a member of the board of governors of the association, having been recommended by the Intermediate Section.

The association is preparing the issuance of a pamphlet setting forth the address of Secretary Hoover which preceded the inaugural meeting in the city of Washington on Oct. 28, extracts from the constitution, and a statement covering fully the objects and purposes of the association.

The following resolution was unanimously passed:

> *Whereas* it has been brought to the attention of this association that it has been reported that the dyestuff manufacturers of the United States are opposed in the tariff legislation to what is known as the American valuation plan, therefore be it
>
> RESOLVED, That the president be instructed to advise the National Manufacturers Association of the United States that it is the sense of this meeting of the Synthetic Organic Chemical Manufacturers Association, manufacturers in the United States of synthetic organic chemicals, including dyestuffs, that the statement, reported in the New York *Times* of Nov. 18, as made by Wilbur F. Wakeman, secretary of the American Protective Tariff League, at a meeting of manufacturers held at the Hotel Pennsylvania, Nov. 17, under the auspices of the National Association of Manufacturers of the United States, to the effect that the administrative feature of the tariff bill now under consideration by the Finance Committee of the United States Senate, providing for American valuation in the determination of ad valorem duties, was opposed, among other influences, by "the domestic dye manufacturers' bloc" is strongly resented, and the association desires that it be clearly understood that it is in entire sympathy with all measures necessary to encourage and adequately protect all American manufacturing industries, including the American valuation plan.

The meeting adjourned to Dec. 9 at 2 p.m., at the Hotel Pennsylvania, New York City.

International Labor Conference to Adopt Convention on Use of White Lead in Painting

Supplementing the item published on page 980 of the November 23 issue, the Washington office of the International Labor Office reports that the International Labor Conference at Geneva adopted, by a vote of 76 to 3, a resolution to draft a convention on the subject of the use of white lead in painting.

The resolution provides for the prohibition of the use of white lead in interior painting, except in factories and railway stations. However, this portion of the convention does not become effective for 6 years. The convention also provides certain regulations for the use of white lead in other forms of painting, such as measures for protection in dry scraping, in spraying with white lead pigments, providing adequate facilities for washing to those using white lead pigments, etc.

The subject has now gone to the drafting committee of the conference, which will draw up the convention in its final form. Owing to the character of the vote above mentioned, there is little doubt that the draft convention in its final form will receive the necessary two-thirds majority.

New Jersey Clay Workers to Hold Annual Meeting

The New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society is perfecting arrangements for its annual meeting to be held at Rutgers College, New Brunswick, N. J., Dec. 16. An interesting technical program is being developed by the committee in charge, which includes Prof. George H. Brown, secretary of the organization; Roy H. Minton and Fred A. Whitaker, both of the General Ceramics Co.; Leslie Brown, of Lenox, Inc.; and A. D. Forst, Jr., of the Robertson Art Tile Co. It is expected to have five or more papers on pertinent subjects, with sessions held both morning and afternoon. The annual election of officers will also take place at this time.

Chemical Warfare at the Arms Conference

The limited discussion of chemical warfare which has been had in connection with the Conference on the Limitation of Armament has revealed that it is very generally conceded that chemical warfare has come to stay. The probabilities are that the conference will not go into the details of the use of gas in warfare and that this weapon will be affected only as there may be agreement to make reductions in all military activities.

Gas-Free Ingots

Metallurgists have for years been searching for means to prevent the absorption of gas by the steel during the melting process and there have been several attempts to devise a method to melt in vacuo. Such a plan, emanating from Norway, is the subject of experiment at the present time at the University of Sheffield, England, along the lines of what is known as the "vacuum converter press." The charge to be converted is melted in a vessel; when the contents are thoroughly fluid the vessel is connected to a vacuum pump, which draws out all the gases that remain, and the vacuum is then sealed and the steel cools without being able to reabsorb. Hence the ingot is wholly sound. According to *The Ironmonger*, the experimenters are satisfied that the idea of a vacuum converter has been definitely proved to be of practical value and that it must be reckoned with in the future of the steel trade. Razor steel of unusually fine quality has been made by the process, and it is claimed that it will be equally successful for making all high-quality grades of cutlery steel at less cost than the present crucible process.

British Discuss Plan to Facilitate Production of Denatured Alcohol

At a London conference recently convened by the Empire Motor Fuels Committee of the Imperial Motor Transport Council of delegates from Empire Governments, at which representatives of British India, the Australian Commonwealth, the Union of South Africa, New South Wales, Tasmania, British Columbia, Quebec and the Crown Colonies were present, a resolution was passed for submission to the appropriate departments of the various governments concerned. The conference discussed the present customs and excise restrictions on alcohol and suitable methods for denaturation of alcohol, and the resolution urges that the various Empire Governments be requested to consider the necessary action to facilitate the production and distribution of industrial and power alcohol throughout the empire. It recommends that each Empire Government should consider the advisability of putting forward for consideration at a further conference proposals regarding the adoption of common methods of, and formulas for, the denaturation of alcohol within the empire so as to cheapen and facilitate operations.

Connecticut Valley Section, A.C.S., Elects Officers

At the November meeting, held at the University Club, Hartford, on Nov. 14, the Connecticut Valley Section of the American Chemical Society elected the following officers:

Chairman, Dr. J. S. Chamberlain of Massachusetts Agricultural College; vice-chairman, Dr. Hill of Wesleyan College; treasurer, G. B. Hogaboon; secretary, Paul Serx, jr., Massachusetts Agricultural College; executive committee, Messrs. Andrews of New Britain, Wolfendale of Springfield and Krieble of Hartford; councilors, Dr. C. R. Hoover and Dr. J. A. Newlands.

Following the business meeting a dinner was served at the University Club. About forty were present. Later in the evening Dr. Chamberlain, of Amherst, gave a historical sketch of the work that led to the discovery of vitamines and a brief account of some of the more recent developments.

Citation by Federal Trade Commission

The Federal Trade Commission has issued a formal complaint against the Procter & Gamble Co., of Cincinnati, Ohio. Thirty days is given for answer, after which the case will be tried on its merits.

The respondent, the complaint alleges, manufactures a soap designated as "P. & G., the White Naphtha Soap," and a washing powder designated as "Star Naphtha Washing Powder," neither of which, it is charged, contains naphtha as a constituent ingredient, but contains instead a petroleum distillate other than naphtha to the extent of 2 per cent or less of the whole ingredients of the washing powder. It is further charged that the distillate used is substantially all lost by volatilization or evaporation by the time the commodity reaches the ultimate consumer. Such practice is alleged to be false and misleading and unfair to competitors of the respondent.

Effect of Impurities in Retarding Crystallization

Professor J. H. Walton, of the department of chemistry of the University of Wisconsin, lectured before the Milwaukee Section of the American Chemical Society on November 18 on the subject, "The Influence of Impurities on the Rate of Growth of Certain Crystals." Prof. Walton's talk had particularly to do with the effect of the presence of impurities upon the rate of crystallization, a subject which is both of theoretical and technical interest. His researches show that substances which are hydrated to the greatest extent show the greatest retarding effect. The retardation is best explained by the slowing down of the reaction by which large molecular aggregates are formed during the process of crystallization. Experiments with undercooled formamide solutions show that here also those substances which are solvated to the greatest extent are the ones that show greatest retardation of the velocity of crystallization.

"Tinkering With Scientific Bureaus"

Through the publication in the *Congressional Record* on Oct. 26 of a plan by Arthur McDonald of Washington, to consolidate all Government scientific bureaus in the Smithsonian Institution, wide circulation has been given to a scheme which is not taken seriously in Washington and which does not have the indorsement of the Smithsonian Institution. Dr. Charles D. Walcott, secretary of the Smithsonian Institution, states that the plan was drawn up and circulated without his knowledge or approval. Representative Melvin O. McLaughlin, who inserted the proposal in the *Congressional Record*, states that he is opposed to the scheme himself, but sees no reason why publicity should not be given to the suggestion so that those concerned could accept it for what it may be worth.

It may be recalled that in an editorial in its issue of Oct. 19, CHEMICAL & METALLURGICAL ENGINEERING pointed out the utter fallacy of the proposal and warned its readers against giving the scheme any serious consideration. As a result, however, of the publication in the *Congressional Record*, the various scientific bureaus and the Smithsonian Institution have received a flood of comment aroused by the suggestion.

To Revise Summary of Tariff Information

The Tariff Commission has been requested by the Senate Finance Committee to prepare for the use of that committee a volume similar in character and contents to the Summary of Tariff Information which was submitted to the Ways and Means Committee in January, 1920. The new volume is to contain much of the information which is in the present Summary and, in addition, later notes and statistics regarding changes which have occurred in the industries since the original volume was published.

It will be recalled that some time ago the proposal was made by Dr. Bernhard C. Hesse that trade associations and scientific societies interest themselves in correcting and bringing up to date this valuable source of industrial information. This opportunity is now offered and it is suggested that any of our readers who are interested in the products of Schedule 1—chemicals, oils and paints of the bill H.R. 7456, submit their comments and criticisms to the United States Tariff Commission not later than December 15.

New Oil Companies in October

During the month of October a total of 55 new companies was organized in the petroleum industry with capital of $50,000 or over, the aggregate indicated investment being $83,450,000. This is an increase of about $30,000,000 in combined capitalization over the figures for September, but a decided decrease from the total of $496,968,000, as was evidenced for similar new companies in the corresponding month of last year.

For the first 10 months of the present year the indicated investment of new companies in this line of industry aggregates $1,129,913,600, divided among 807 companies. In the same period of 1920 a total of 2,327 new companies were formed, with a combined capitalization of $2,410,944,700. Since the beginning of the present year, 27 companies have been organized with a capital of $10,000,000 or greater.

Obituary

WILLIAM H. STENGEL, treasurer of the George Stengel Co., Inc., Newark, N. J., leather manufacturer and son of the late George Stengel, founder of the company, died at his home, 64 Johnson Ave., Newark, Oct. 28, from a complication of diseases. He was fifty-three years of age.

HOWARD THOMAS, vice-president and general manager of the Eastern Oil Co., Buffalo, N. Y., died on Nov. 12, aged fifty-eight years.

Personal

Dr. E. D. BALL, recently appointed director of scientific work for the Department of Agriculture, has been designated as the representative of that department on the research information service committee of the National Research Council. He fills the place made vacant by the resignation of Dr. Carl L. Alsberg. Dr. Alsberg's place on the Division of Federal Relations of the National Research Council has been filled by Dr. Frederick D. Power, for many years the director of the Wellcome Research Laboratory in London, and now in charge of the phytochemical laboratory of the Bureau of Chemistry.

Prof. EDWARD BARTOW, head of the department of chemistry at the State University of Iowa, has just returned from a trip to Tulsa, Okla., where he was engaged in an investigation of the water supply of that city.

ROBERT F. BROWN, formerly connected with the banking firm of Weil, Farrell & Co., Boston, Mass., has been elected treasurer of the Dayton Rubber Manufacturing Co., Dayton, Ohio, with offices in that city.

A. S. CARLTON has been elected president of the Union Chemical Co., Boston, Mass. For some time past he has been vice-president of the company.

BURGESS DARROW has been appointed development manager for the Goodyear Tire & Rubber Co., Akron, Ohio. He is a graduate of the Massachusetts Institute of Technology and has been connected with the company for the past ten years in tire development and compounding work.

W. MCA. JOHNSON has recovered control of his electrothermic zinc-lead process and expects to take steps to introduce it commercially.

Dr. J. A. LECLERC, who is a recognized expert on cereal products and has been associated with one of the large corn mills for a number of years, has been sent as a special trade commissioner to confer with European authorities upon the use of corn grits as a food.

T. A. PATTERSON has severed his connection with the Niagara Alkali Co., Niagara Falls, N. Y., to become technical director of the Belle Alkali Co., Belle, W. Va.

N. A. V. PAULSSON, who as consulting engineer for Corning & Co., Albany, N. Y., has designed an electric iron and steel plant for the Cia Electro Metallurgica Brasileira, has sailed for Brazil to supervise the installation of the furnaces and the early operation of the plant. His address will be Ribeirão Preto, São Paulo, Brazil, for several months.

Prof. J. H. WALTON, of the department of chemistry of the University of Wisconsin, lectured before the Milwaukee Section of the American Chemical Society on Nov. 18, on the subject "The Influence of Impurities on the Rate of Growth of Certain Crystals."

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 28, 1921.

The chemical market during the past week has shown encouraging signs of increased buying power, although again interrupted by a holiday period. Business in most items has been of a satisfactory nature and producers are optimistic about future conditions. An outstanding feature of the market was the position of caustic soda in foreign fields. Large tonnage sales have been authoritively recorded among leading manufacturers, with the bulk of shipments going to European and South American countries. It is a source of gratification to know that American producers are again successfully able to compete with European factors. The call for caustic and ash at home has also been renewed. There was some future business placed and more interest is manifested in covering requirements over next year. Producers have announced a standard price for 1922, although there have been various rumors around the market of different contract prices. Yellow prussiate of soda commanded increased interest from the consuming trade and the market was a trifle firmer at the close of the week. Producers of oxalic acid have been much stronger in their views, and goods at the works were quoted considerably higher. Bichromate of soda is moving in slower fashion with actual sales being recorded at lower figures. Caustic potash has been somewhat overlooked during the week and spot prices were a shade weaker. Imported chlorate of potash was about the most unstable item on the market and holders of good-sized quantities were eager to sell regardless of standard quotations. Consumers of bleaching powder have shown an eagerness for full contract deliveries, and supplies appear to be relatively light on both the imported and domestic material. It can be stated, in general, that the outlook for the chemical market is noticeably improving. There is no doubt that the big shot for expansion depends upon the result of the armament conference. Should all the nations concerned agree to reductions of armament, there will be a prompt response in the foreign exchange market which will mean a big boom in our export trade. Domestic soap, paper, textile and tanning industries are showing more interest in the market and new orders are coming in for larger quantities than noted two or three months ago. Those close to the pulse of trading are of the opinion that the spring months will see trade conditions in a very healthy and normal condition.

CHEMICALS

Prices on *oxalic acid* have moved upward during the past week and at the close producers held prices firm at 14½c. per lb., f.o.b. works. Sales on spot were transacted during the week at prices ranging from 14½@16c. per lb., according to brand and quantity. Leading sellers were not inclined to part with stocks under 15c. at the close of the week. The market seems to have became steady again and higher prices are expected. Spot prices on *prussiate of soda* were a fraction firmer at the close and sales were made at 14½c. per lb., ex-store. Some dealers quoted up to 14¾c. Shipment prices remained unchanged at 14½c. per lb. c.i.f. New York. Dealers of *bichromate of soda* were not desirous of quoting under 8c. per lb. for spot material, although some business was done down to 7¾c. The general quotation ranged from 8@8½c. per lb. for prime goods. The demand has remained moderate with small orders attracting the most attention. Commercial *white arsenic* is quoted by leading producers at 6½@7c. per lb. for spot and shipment material. The demand has shown a slight improvement of late. Second hands still quote the market at 6@6¼c. per lb. according to quantity. Recent importations of *chlorate of potash* have placed the market in a very unsettled condition and dealers have had to resort to price slashing in an effort to distribute supplies. The price ranges from 5½@6c. per lb. on imported material for spot. Domestic goods is unchanged at 12c. per lb. f.o.b. works. Sales of *caustic potash*, 88-92 per cent, during the week were reported at 5¾@5¾c. per lb. The demand has not shown any signs of improvement and prices are barely steady. Large consumers seem to have well supplied themselves with shipment material. The big encouraging feature of the chemical market was the position of *caustic soda* both here and abroad. There has been a marked improvement in the export field since the beginning of the month with reports varying as to the actual amount of business that was placed. Italy was reported to have bought large tonnages at prices ranging from $4.80@$5 per 100 lb. c.i.f. Italian ports. South America is also an added buyer of caustic soda with Argentina doing the most purchasing. Producers stated that the demand for domestic material has shown a steady increase. Several carlots have been moved at $3.90 per 100 lb., with lesser quantities selling around $4.10. Manufacturers of *copper sulphate* have not advanced the price of this chemical, although the trade is looking for an upward revision on account of the strength in copper metal. The demand has not been at all encouraging of late and this, no doubt, has kept producers from

advancing prices. The carlot price is 5¼c. per lb. for standard 99 per cent, large crystals. The market on soda ash in single bags has not shown much change from the previous quotation. The domestic demand has not been up to the standard and prices remained around $2 per 100 lb. for carload quantities. Smaller lots commanded up to $2.40 per 100 lb. Barrels were quoted at $2.40@$2.50 per 100 lb. The trade was somewhat surprised that ash was not included in the recent demand for export.

Coal-Tar Products

The coal-tar products market during the past week has shown practically no improvement, with prices in most directions unchanged. Small-lot business seems to be attracting the most attention, with an increased amount of inquiries and orders recorded. Contract business is almost unheard of in the trade, as most consumers feel that the general tendency is toward lower rather than higher levels. Producers and buyers are operating in an extremely cautious manner, but are quite optimistic that business will materially improve with the turn of the year. Stocks in consumers' hands are noticeably light and any upturn in the market will, no doubt, tend to bring a considerable amount of orders. The demand for *benzene* still far exceeds the supply, but refiners are experiencing an improvement in stocks with the increased activity in the steel industry. First hands are quoting 27@33c. per gal. Resale material is extremely difficult to locate. The tone of the *cresol* market is somewhat easier, with prices about 1c. per lb. lower. Quotations range from 15@16c. per lb. The market on *phenol* is stronger and holders of prime material are somewhat firmer in their views. Sales under 10c. per lb. are quite rare and quotations range from 10@14c. per lb. according to quantity and seller. Sales on *metaphenylenediamine* were made down to $1.05 per lb., but the general quotation was $1.10@$1.15 per lb. The demand continues fair in view of the adverse conditions in the garment trade. Resale quotations on *naphthalene flakes* are around 6½@7c. per lb. The market is a trifle firmer and there is some hope for higher prices. Makers ask 7½c. per lb. for the flake and 8@8½c. for the balls. Sales of *alphanaphthylamine* were made at 30c. per lb., despite rumors of lower figures. This seemed to be the inside price, with holders asking up to 32c. for smaller quantities. Sales of *aniline oil* were made at 18c. per lb., with some sellers asking up to 20c. The market is reported a shade stronger, with most of the low-priced material either sold or withdrawn from the open market. Makers of *beta naphthol* ask 32c. per lb., with sales made by second hands down to 30c. The tone of the market seems to have noticeably improved, although there are still holders of large sized quantities. First hands on *dichlorbenzene* are holding prices at 6@8c. per lb. The demand is not exceptionally strong, but the general tone of the market is steady.

The St. Louis Market

St. Louis, Nov. 25, 1921.

Since the last letter there has been practically no change in the drug and chemical markets as far as activities are concerned. However, a few minor price changes have taken place, principally upward. The second-hands are generally being eliminated but importers are still very active.

Alkalis

The market continues firm on *caustic*, with the solid selling at $4 per 100 lb., point of production in carlots, the flake in drums at $4.25 per 100 lb. for the 76 per cent solid material. *Soda ash* is in light demand, with free movements, the price remaining at $3 per 100 lb. in barrels ex-warehouse. The market on *bicarbonate* and *sal soda* remains very quiet, with few sales at $2.90 and $2.15 per 100 lb. in barrels respectively.

Chemicals, Drugs and Pharmaceuticals

The market on *acetphenetidin* has been strengthened by the elimination of the price-cutting competition. *Ammonia water* is moving through regular channels. *Ammonium sulphate, pure granular*, continues in good inquiry and demand. *Bismuth salts* are moving in a very lively manner, especially the *subcarbonate*. Large sales of *bromides* have been reported. Orders for *carbon bisulphide* are dropping off. *Creosotes* and *guaiacols* are commanding a better position and should continue to do so, as these are seasonable products. *Ether* continues to move freely. *Glycerin* has advanced slightly and is now selling at 14½c. per lb. in drums. The demand is very strong and even higher prices may be expected. *Glycerophosphates* are moving in larger volume. There appears to be a better demand for *hypophosphites*. *Hypo* and other photograhic chemicals are not so active. *Iodides* are very lively. Of the narcotics, *codeine* is the most active of the group. *Salicylates* are moving in good volume. The *sulphur* market is very sluggish. Prices have not declined, but are not firm by any means, being $1.35 per 100 lb., carlots f.o.b. mines, for 88 per cent commercial. *Zinc oxide* is in fair demand and movement nominal. Future business looks promising. Price remains at 7½c. in barrels and 7¼c. in bags, f.o.b. works, for the standard brands.

Acids

Movement of the heavy mineral acids has been retarded this month owing to customers having anticipated their November requirements at the time of the threatened railroad strike. Factors reduced their price on *acid phosphoric sirupy*. *Acid tartaric* is very steady.

Vegetable Oils and Naval Stores

Turpentine is somewhat weaker today than at the last report, having declined from 85c. to 83c. for single barrel orders, with a 4c. differential in 5-bbl. lots. The *castor oil* demand has fallen off slightly, but the price remains steady at 12½c. in barrels and 12c. in returnable drums. *Linseed oil* is slow and steady at the same price prevailing in the last report—namely, 70c., basis raw oil ex-warehouse.

The Iron and Steel Market

Pittsburgh, Nov. 25, 1921.

Except in tubular goods and tin plate, the finished steel market continues to present an appearance of decided dullness, in contrast with the increasing activity observed up to about the middle of October. That is the appearance seen in market circles, but there is the inconsistent thing that production of steel does not seem to decrease at all. There are some cases of increases and in the aggregate there cannot have been much decrease. Steel ingot production may fairly be estimated at between 40 and 45 per cent of capacity, against the 44 per cent rate shown for October, the highest rate since February.

It is quite certain that mills are accumulating no stocks and it is equally certain that neither distributors nor manufacturing consumers are accumulating stocks. There is a fresh effort to liquidate stocks completely, from the double influence of the inventory date being approached and a general reduction in freight rates being expected.

There seems to be no flaw in the argument that the actual ultimate consumption of steel is maintained and is at what may be considered a fair rate by comparison with earlier months in the year. Yet one of the dull seasons of the year has arrived or is being approached. It seems quite reasonable to assume therefore that consumption is to continue at substantially the recent rate, subject to increases when conditions favorable to an increase develop. Four factors at least should make for eventual improvement, within the discernible future:

1. The approach of spring, which normally brings seasonal increase in consumption, this influence being likely to be felt in February.
2. Increasing easiness in money.
3. General reduction in freight rates, which all have been waiting for, in all probability to come between Jan. 1 and April 1.
4. Further liquidation in building costs, and in readjustment and harmonizing in prices and wage rates generally.

These points relate to the consumption of steel. As to demand upon the steel mills, another point can probably be counted upon. There has been drastic liquidation in stocks of steel in the hands of buyers. Steel prices, already low by comparison with commodities and values generally, continue to sag and are likely to reach a level from which

a slight upward reaction could reasonably be expected. With such a point reached and with stocks in buyers' hands at an altogether unnaturally low level, a stocking up process is extremely likely to be seen, and even if pursued very conservatively this would bring an added demand upon the steel mills. Then there would be present consumption plus an increase in consumption plus a partial restoration of stocks. Within the early months of the new year this may not unreasonably be expected to produce a mill operation of 75 per cent or more.

Lines of Demand

Demand upon the pipe mills seems to have increased somewhat even up to date. It certainly has not noticeably decreased. In the past fortnight the National Tube Co. (Steel Corporation) has increased its active blast furnaces from four to six, partly because of exhaustion of stocks of pig iron, partly because of increased demand. There is an equally fair call for standard pipe and for oil country goods. The latter line does not show the usual seasonal decline in activity, partly on account of sharp increases in oil prices in recent months, partly because there is now more oil territory where winter interferes less. Prices on these lines are fairly well maintained. In line pipe there has been severe cutting, said to be well below the cost of production. Each of the three oil companies in the new Mexia field in Texas contemplates laying a 200-mile mine of 8-in. pipe.

Tin plate mill operations are increasing, being supported by current demand of seasonal character and by the entering of specifications against requirements for the first quarter of the new year, furnishing mills extra employment now, shipments to begin after Jan. 1. The $4.75 price announced Nov. 3 appears to be well held.

Railroads continue to exhibit interest in rolling stock, first exhibited in practical way in the past two or three weeks.

Bars, shapes and plates appear to be in quite moderate demand in general. Sheets are distinctly duller than a month ago. Wire products appear to have been tapering off, some distributors evidently having accumulated stocks through specifying against contracts made in anticipation of the price advance of Sept. 12.

Steel Prices

Bars, shapes and plates are more frequently done at 1.50c. than a fortnight ago, but small orders, down to carloads, usually involve a slightly higher price. The continued sagging suggests that eventually there will be a turning point, which is likely to be at 1.50c. or a trifle less. Sheet prices are in a state of flux. After the failure of the recent attempt of some independents to advance the market from 3c. to 3.25c. prices began to sag, some recent quotations being at 2.75c. or possibly a trifle less. It being intimated that the Steel Corporation was about to announce prices for first quarter, independents have been disposed in the past week to withdraw prices under 3c. for black and 4c. for galvanized, and if this withdrawal proves complete the prices mentioned may be announced for the first quarter. The recent attempt to advance wire from 2.60c. to 2.70c. and nails from $2.90 to $3 appears to have been abandoned, not enough contract business being booked at existing prices to justify an advance, while it may be that present prices are being shaded, by extension of old contracts and by other methods.

Pig iron continues dull, with a softening tendency when competitive business is offered. The valley market remains quotable at $20 for bessemer, $19 for basic and $20.50 for foundry, but these prices could possibly be shaded on a round tonnage.

Connellsville coke has continued to weaken, with a slight accumulation on track and with continued failure of additional consumption to develop. Prompt furnace coke is down to a range of $3@$3.10, while foundry is not particularly strong at $4@$4.50. The Trumbull-Cliffs Furnace Co. contemplates blowing in its furnace Jan. 1 and is out with an inquiry for 18,000 tons a month for first quarter or first half, apparently expecting to buy at $3.25, a price not yet quoted for the period.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½– $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.75 – 3.00	3.25 – 3.50
Acetic, 56 per cent	100 lbs.	6.00 – 6.25	6.50 – 7.00
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.00 – 10.50	10.75 – 11.00
Boric, crystals	lb.	.12½– .12½	.13 – .13½
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	..... –	.45 – .47
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.12½– .13
Lactic, 44 per cent tech	lb.	.09½– .10	.10½– .12
Lactic, 22 per cent tech	lb.	.04½– .05½	.06 – .07
Molybdic, C.P.	lb.	3.25 – 3.50	3.60 – 4.00
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg.	lb.	.06½– .06½	.06½– .07
Nitric, 42 deg.	lb.	.06½– .07	.07½– .07½
Oxalic, crystals	lb.	.14½– .15	.15½– .16
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.90 2.00
Sulphuric, 60 deg., tank cars	ton	..... –	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	..... –	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	..... – .....
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent(oleum) tank cars	ton	21.00 – 22.00	..... – .....
Sulphuric, fuming, 20 per cent(oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent(oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.75 – .85
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, imported crystals	lb.	..... –	.26½– .27½
Tartaric acid, imported, powdered	lb.	..... –	.27½– .28½
Tartaric acid, domestic	lb.	..... –	..... – .35
Tungstic, per lb. of WO	lb.	..... –	1.10 – 1.20
Alcohol, Ethyl	gal.	..... –	4.65 – 5.00
Alcohol, Methyl (see methanol)	....	..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.37 – .38
Alcohol, denatured, 190 proof	gal.	..... –	.35 – .36
Alum, ammonia, lump	lb.	.03½– .03½	.04 – .04½
Alum, potash, lump	lb.	.03½– .04	.04½– .04½
Alum, chrome lump	lb.	.08½– .08½	.08½– .09
Aluminum sulphate, commercial	lb.	.01½– .02	.02½– .02½
Aluminum sulphate, iron free	lb.	.02½– .03	.03½– .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½– .07½	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.31 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.07 – .07½	.07½– .07½
Ammonium chloride, granular (gray salammoniac)	lb.	.07 – .07½	.07½– .07½
Ammonium nitrate	lb.	.07½– .07½	.07½– .08½
Amylacetate tech	gal.	..... –	2.40 – 2.65
Arsenic oxide, (white arsenic) powdered	lb.	.06½– .06½	.06½– .07
Arsenic, sulphide, powdered (red arsenic)	lb.	.11½– .12	.12½– .13
Barium chloride	ton	46.00 – 48.00	49.00 – 55.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.06½– .07	.07½– .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½– .05
Bleaching powder (see calc. bypochlorite)	....	..... –	..... – .....
Blue vitriol (see copper sulphate)	....	..... –	..... – .....
Borax (see sodium borate)	....	..... –	..... – .....
Brimstone (see sulphur, roll)	....	..... –	..... – .....
Bromine	lb.	.27 – .28	.28½– .30
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½– .04½	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½– .02	.02½– .02½
Calcium hypochloride(bleach'g powder)	100 lb.	2.25 – 2.30	2.35 – 3.00
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.91 – .95
Carbon bisulphide	lb.	.06½– .06½	.07 – .07½
Carbon tetrachloride, drums	lb.	.10½– .10½	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	....	..... –	..... – .....
Caustic soda (see sodium hydroxide)	....	..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½– .10
Chloroform	lb.	..... –	.40 – .43
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas (see iron sulphate)	....	..... –	..... – .....
Copper carbonate, green precipitate	lb.	.19 – .19½	.20 – .21
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	lb.	.05½– .05½	.05½– .06
Cream of tartar (see potassium bitartrate)	....	..... –	..... – .....
Epsom salt (see magnesium sulphate)	....	..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	..... –	.70 – .80
Ethyl Acetate pure (acetic ether, 98% to 100%)	gal.	..... –	.95 – ....
Formaldehyde, 40 per cent	lb.	.11 – .11½	.11½– .12½
Fusel oil, ref.	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.50 – 1.75
Glauber's salt (see sodium sulphate)	....	..... –	..... – .....
Glycerine, C. P. drums extra	lb.	..... –	.14½– .15
Iodine, resublimed	lb.	..... –	3.50 – 3.60
Iron oxide, red	lb.	..... –	.12 – .18
Iron sulphate (copperas)	ton	18.00 – 19.00	20.00 – 23.00
Lead acetate	lb.	..... –	.10½– .12½
Lead arsenate, powd.	lb.	.15 – .15½	.15½– .16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08 – .08½	.08½– .09
Lithium carbonate	lb.	..... –	1.40 – 1.50
Magnesium carbonate, technical	lb.	.08 – .08½	.09 – .10
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 2.75	..... – .....
Magnesium sulphate, technical	100 lb.	..... –	1.10 – 1.75
Methanol, 95%	gal.	..... –	.66 – .68
Methanol, 97%	gal.	..... –	.70 – .72
Nickel Salt, double	lb.	..... –	.12 – .12½
Nickel salt, single	lb.	..... –	.14 – .14½
Phosgene (see carbonyl chloride)	....	..... –	..... – .....
Phosphorus, red	lb.	.40 – .41	.42 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.11 – .11½	.11½– .12

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .... – $....	$0.28 –$0.30
Potassium bromide, granular	lb.	..... –	.15 – .20
Potassium carbonate, U. S. P.	lb.	.15 – .16	.17 – .20
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05½ – .06	.06½ – .12
Potassium cyanide	lb.	..... –	.40 – .45
Potassium hydroxide (caustic potash)	lb.	.05½ – .06	.06½ – .08
Potassium iodide	lb.	..... –	2.60 – 2.75
Potassium nitrate	lb.	.07½ – .07¾	.08 – .09
Potassium permanganate	lb.	.17 – .18	.18½ – .21
Potassium prussiate, red	lb.	.28 – .29	.29½ – .30
Potassium prussiate, yellow	lb.	.21 – .21½	.21½ – .22
Rochelle salts (see sodium potas. tartrate)	....	....	..... – .....
Salammoniac (see ammonium chloride)	....	....	..... – .....
Sal soda (see sodium carbonate)	....	..... –	..... – .....
Salt cake (bulk)	ton	..... –	20.00 –22.00
Silver cyanide	oz.	..... –	1.10 – 1.20
Silver nitrate	oz.	..... –	.45 – .46
Soda ash, light	100 lb.	2.00 – 2.10	2.15 – 2.50
Soda ash, dense	100 lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04 – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium bichromate	lb.	.08 – .08¼	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .05	.05½ – .06
Sodium borate (borax)	lb.	.05½ – .06	.06½ – .07
Sodium carbonate (sal soda)	100 lb.	1.80 – 1.90	2.00 – 2.20
Sodium chlorate	lb.	.07½ – .07¾	.08 – .08½
Sodium cyanide	lb.	.28 – .28½	.29 – .30
Sodium fluoride	lb.	.11 – .12	.12½ – .14
Sodium hydroxide (caustic soda)	100 lb.	4.00 – 4.10	4.15 – 4.50
Sodium hyposulphite	lb.	..... –	.03½ – .03¾
Sodium nitrite	lb.	.06¾ – .07	.07¼ – .07¼
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04¾	.04¾ – .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.21 – .24
Sodium prussiate, yellow	lb.	.14½ – .14¾	.15 – .15½
Sodium silicate, solution (40 deg.)	100 lb.	.95 – 1.00	1.10 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.30 – 2.40	2.45 – 3.00
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04½ – .04¾	.05 – .05½
Sodium sulphite, crystals	lb.	.03½ – .03¾	.04 – .04½
Strontium nitrate, powdered	lb.	.13 – .14	.14½ – .20
Sulphur chloride, red	lb.	.06 – .06½	.06½ – .07
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38½
Zinc carbonate, precipitate	lb.	.16 – .16½	.17 – .17
Zinc chloride, gran.	lb.	.09 – .09½	.09½ – .10
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11½ – .11¾	.11¾ – .12½
Zinc oxide, XX	lb.	.07½ – .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.30 — .32
Aniline oil, drums extra	lb.	.18 — .20
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1.45
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.62 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.30 — .34
Beta-naphthyla mine, sublimed	lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)	lb.	.15 — .16
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.10
Dimethylaniline	lb.	.45 — .60
Dinitrobenzene	lb.	.23 — .27
Dinitroclorbenzene	lb.	.20 — .25
Dinitronaphthalene	lb.	.30 — .35
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.30 — .35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.00 — 1.10
Meta-phenylenediamine	lb.	1.10 — 1.15
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.65 — 1.70
Naphthalene crushed, in bbls.	lb.	.06½ — .08
Naphthalene, flake	lb.	.06½ — .08
Naphthalene, balls	lb.	.08 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.70 — 1.80
Para-dichlorbenzene	lb.	.12 — .15
Paranitroaniline	lb.	.75 — .80
Para-nitrotoluene	lb.	.80 — .85
Para-phenylenediamine	lb.	1.70 — 1.75
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.40 — .50
Phenol, U. S. P., drums	lb.	.10 — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.50 — 1.60
Resorcinol, pure	lb.	2.00 — 2.25
Salicylic acid, tech., in bbls.	lb.	.20 — .21
Salicylic acid, U. S. P.	lb.	.22 — .23
Salol	lb.	.70 — .72
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.27 — .30
Tolidine	lb.	1.30 — 1.35
Toluidine, mixed	lb.	.43 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.24 — .25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.34 — .38
Candellila wax	lb.	.24 — .24½
Carnauba, No. 1	lb.	.45 — .46
Carnauba, No. 2, North Country	lb.	.23 — .23½
Carnauba, No. 3, North Country	lb.	.14 — .14½
Japan	lb.	.21 — .21½
Montan, crude	lb.	.04 — .04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03¾ — .....
Paraffine waxes, refined, 118-120 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 125 m.p.	lb.	.04½ — .04½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04½ — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.05 — .05½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ — .06
Stearic acid, single pressed	lb.	.09½ — .....
Stearic acid, double pressed	lb.	.09½ — .....
Stearic acid, triple pressed	lb.	.10½ — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.60 —	5.60
Rosin E-I	280 lb.	5.65 —	5.70
Rosin K-N	280 lb.	6.25 —	6.80
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.80 —	.....
Wood turpentine, steam dist.	gal.	.78 —	.....
Wood turpentine, dest. dist.	gal.	.76 —	.....
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.50
Retort tar, bbl.	500 lb.	—	10.50
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.39 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.37
70-72 deg., steel bbls. (85 lb.)	gal.	.35
68-70 deg., steel bbls. (85 lb.)	gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23

Fertilizers

Ammonium sulphate, bulk and d. bags	100 lb.	$2.60 —	2.90
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Cyanamide, f.o.b. works	unit	4.50	
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.40 —	2.45
Tankage, high grade, f.o.b. Chicago	unit	2.75 —	3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c.	ton	4.50 —	6.50
Tennessee, 78-80 p.c.	ton	8.50 —	9.00
Potassium muriate, 80 p.c.	ton	37.00 —	40.00
Potassium sulphate	unit	1.00 —	1.10

Crude Rubber

Para—Upriver fine	lb.	$0.21½ —	.22½
Upriver coarse	lb.	.13½ —	.14
Upriver caucho ball	lb.	.13 —	.13½
Plantation—First latex crepe	lb.	.17½ —	.18
Ribbed smoked sheets	lb.	.17¼ —	.18
Brown crepe, thin, clean	lb.	.15 —	.....
Amber crepe No. 1	lb.	.17½ —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11¼ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13 —	.13½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.09 —	.09½
Cocoanut oil, Cochin grade, in bbls.	lb.	.10 —	.10½
Corn oil, crude, in bbls.	lb.	.09 —	.09½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07½
Cottonseed oil, summer yellow	lb.	.08¾ —	.09
Cottonseed oil, winter yellow	lb.	.09½ —	.09¾

Linseed oil, raw, car lots (domestic)	gal.	.65	—	.66
Linseed oil, raw, tank cars (domestic)	gal.	.60	—	.61
Linseed oil, in 5-bbl lots (domestic)	gal.	.68	—	.69
Olive oil, Denatured	gal.	$1.15	—	$1.20
Palm, Lagos	lb.	.07½	—	.08
Palm, Niger	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08½
Peanut oil, refined, in bbls	lb.	.11½	—	.11½
Rapeseed oil, refined in bbls	gal.	.83	—	.84
Rapeseed oil, blown, in bbls	gal.	.90	—	.92
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08½	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07¼	—	....
FISH				
Light pressed menhaden	gal.	$0.40	—	....
Yellow bleached menhaden	gal.	.42	—	....
White bleached menhaden	gal.	.45	—	....
Blown menhaden	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	....
Blanc fixe, dry	lb.	.04	—	.04½
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light	lb.	.04½	—	.05
Chalk, Precipitated, English, light	lb.	.04½	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00	—	....
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04½	—	.05
Graphite, high grade amorphous crude	lb.	.00½	—	.02½
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y	per ton	55.00	—	60.00
Magnesite, calcined	per ton	50.00	—	65.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.....	—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	.70
Shellac, orange superfine	lb.	.78	—	.80
Shellac, A. C. garnet	lb.	.58	—	.60
Shellac, T. N	lb.	.68	—	.70
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in.	less than carlot	1.000	1250.00
	carload lots	1.000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		52- 55
Chrome cement, 40-45% Cr_2O_3	net ton		30- 32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton		33- 35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		35- 40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		30- 35
Magnesite brick, 9-in. straight	net ton		65- 70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b Chicago district	1,000		40- 42
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		42- 45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000		35- 38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	—	$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.11	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.11	—	12
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German	gross ton	58.00	—	59.00
Spiegeleisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	57.00	—	59.00
Ferrosilicon, 75%	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00	—	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00	—	23.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens	net ton	4.00	—	4.25
Coke, furnace, f.o.b. ovens	net ton	3.00	—	3.25
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.23	—	.24
Manganese ore, chemical (MnO_2)	net ton	55.00	—	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.45	—	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11	—	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.50
Aluminum, 98 to 99 per cent	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese	4.60
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29.625
Lead, New York, spot	4.65@4.70
Lead, E. St. Louis, spot	4.35
Zinc, spot, New York	5.10
Zinc, spot, E. St. Louis	4.65

OTHER METALS

Silver (commercial)	oz.		$0.66½
Cadmium	lb.		1.00-1.25
Bismuth (500 lb. lots)	lb.		1.50@1.55
Cobalt	lb.		3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.		1.25
Platinum	oz.		80.00
Iridium	oz.		150.00@170.00
Palladium	oz.		55.00-60.00
Mercury	75 lb.		44.00-45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.00
Copper bottoms	28.50
Copper rods	19.50@20.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	25.00
Brazed bronze tubing	27.75
Seamless copper tubing	20.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.75@10.25	9.25	9.50
Copper, heavy and wire	9.25@9.50	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.50@3.75	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.88	$2.88	$2.78
Soft steel bars	2.78	2.78	2.68
Soft steel bar shapes	2.78	2.78	2.68
Soft steel bands	3.42	3.48	3.28
Plates, ¼ to 1 in. thick	2.88	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MOBILE—The United States Turpentine & Rosin Co., organized with a capital of $1,250,000, Frank W. Boynton, president, has preliminary plans under way for the establishment of a new plant at Crichton, Ala., for the manufacture of turpentine, rosin and affiliated produces. The machinery installation will include crushing equipment, retorts, distilling apparatus, etc.

MOBILE—The International Cotton Protecting Co. has plans under way for the construction of a local plant for the manufacture of special raw cotton preservatives. Work will be commenced at an early date.

Georgia

ELBERTON—Fire, Nov. 9, destroyed a portion of the plant of the Elberton Cotton Oil Co., with loss estimated in excess of $40,000, including equipment. The plant will be rebuilt.

ATLANTA—The Diamond Holfast Rubber Co. has awarded a contract to the Griffin Construction Co., for the erection of its proposed local plant, estimated to cost about $25,000. A. Ten Eyck Brown, Forsyth Bldg., is architect.

Louisiana

CEDAR GROVE—The Shreveport Lamp Chimney Co., has preliminary plans under way for the erection of an addition to its local plant, to include the installation of new machinery. Thomas F. McBride, Salem, W. Va., is president of the company.

Maryland

BALTIMORE—The McHenry-Millhouse Mfg. Co., South Bend, Ind., is planning for early operations at the local plant of the Electrolytic Zinc Co., 1200 South 16th St., recently acquired, to be used for the manufacture of coating paints and compounds for roofing service, asphalt roofing specialties, etc. The building will be remodeled and enlarged, and necessary machinery installed. J. L. Kittinger is general manager.

BALTIMORE — The Spanish-American Cork Products Co. has acquired the plant and business of the Spanish-American Cork & Specialty Co., with works at Westport, near Baltimore, and in the future will operate at this location. The former factory of the company, recently destroyed by fire, will not be rebuilt at the present time. Plans are under way for expansion at the Westport plant to cost about $150,000, with proposed machinery installation for the manufacture of cork automobile accessories to represent an investment of close to $50,000. Oscar T. Harms is president, and Oscar L. Swope, treasurer.

Massachusetts

SPRINGFIELD—Flink & Olson, 518 Page Blvd., have had plans prepared for the erection of a 1-story foundry, 32 x 60 ft. Stuart & Tessler, 94 State St., are architects.

Michigan

PORT HURON—Contract for the new addition to be erected at the plant of the Port Huron Sulphite & Paper Co., has been awarded to Alfred J. O'Sullivan, Port Huron. It will be 2-story and basement, 70 x 100 ft., located on Black River St., with estimated cost of about $150,000, including machinery. Walter Wythe, 509 Chestnut Ave., is architect.

THREE RIVERS—The Eddy Paper Co. is reported to be considering the construction of two new manufacturing units at its plant, estimated to cost in excess of $5,000,000. H. L. Vanderherst is vice-president.

BLACK CREEK—The Outagamie Limestone Co., 75 Thirtieth St., Milwaukee, Wis., is perfecting plans for the erection of a new limestone plant in the vicinity of Black Creek, estimated to cost about $200,000 with machinery. H. O. Weldon, 10 South La Salle St., Chicago, Ill., is engineer.

KALAMAZOO—The King Paper Co. and the Monarch Paper Co., both of Kalamazoo, with the Bardeen Paper Co., Otsego, Mich., have been consolidated under the name of the Allied Paper Mills, capitalized at $6,000,000. The different mills of the merged company include 10 paper machines and 3 coating mills, giving employment to over 1,400 operatives under normal production. It is proposed to acquire, by control or purchase, a pulp mill to insure a supply of bleached pulp for production. A general expansion in plant facilities is planned. A. L. Pratt, heretofore head of the King Paper Co., is president of the new corporation.

Minnesota

MINNEAPOLIS—The Minnesota Mfg. Co., 722 North Third St., manufacturer of chemical compounds, etc., has rejected bids received for the construction of its proposed 3-story plant on Eighth Ave., and will call for new bids early in the coming spring. The factory is estimated to cost about $35,000. E. J. Miller is secretary.

Missouri

ST. LOUIS—The General Mfg. Co., Eighteenth and Pine Sts., has leased a 2-story building in the vicinity of its works, and will establish a plant for the manufacture of rubber specialties, leather belting, etc. The structure will be remodeled and improved to accommodate the industry.

CAPE GIRARDEAU—The National Mining Co. has acquired a local site and is said to have plans in preparation for the erection of a new silica refining plant, estimated to cost in excess of $75,000.

Montana

GREAT FALLS—The American Refining Co., Okmulgee, Okla., is planning for the construction of a new oil refinery at Great Falls, to utilize crude oil production from the Cat Creek district.

New Jersey

WOODBRIDGE—Fire, Nov. 14, destroyed the plant of the Sepoy Chemical Co., Edgar's Station, near Woodbridge, with loss estimated at about $60,000. The factory was used for the manufacture of dyes, colors and kindred chemical products.

DOVER—The Thomas Iron Co. has commenced excavations for the construction of an addition to its concentrating mill at the Richard Mine, near Dover. The extension, with machinery, is expected to increase the present output of 4,000 tons of ore per month to more than 20,000 tons. A new crushing process will be adopted at the plant.

TRENTON—The Nottingham Rubber Co., 150 East State St., recently organized with a capital of $500,000, has obtained options on a tract of land near Philadelphia, Pa., as a site for the erection of its proposed new plant for the manufacture of rubber products, including a patented puncture-proof inner tube for automobile tires. Preliminary plans for the factory are under way and it is said that erection will be commenced at an early date. The company is headed by C. Francis Fisk and Samuel H. Bell.

New York

HUDSON—The International Cement Co. has awarded a contract to the Turner Construction Co., 244 Madison Ave., New York, for the erection of a 1-story building at its local plant, 160 x 600 ft., estimated to cost about $200,000. Excavation work will be placed under way at once.

LONG ISLAND CITY—The Grasselli Chemical Co., Independence Road, Cleveland, O., has filed plans for the erection of a 1-story building at its local plant, 80 x 250 ft., at Morgan St. and Montrose Ave. The Barney Ahlers Co., 110 West Fortieth St., New York, has the construction contract.

Ohio

ASHLAND—The Dragon Rubber Co., North Galloway St., is considering the erection of an addition to its plant.

SANDUSKY—The Farrell-Cheek Steel Foundry Co., has construction under way on a 1-story plant addition, 90 x 180 ft., and plans for early occcupancy. Herbert Farrell is president.

MARBLEHEAD—The Kelly Island Lime & Transport Co., Leader-News Bldg., Cleveland, O., has commenced the erection of the steel work for its new local crushing plant, to be 60 x 60 ft., and 170 ft. high, and plans to have the structure ready for the machinery installation at an early date.

Oregon

PORTLAND—The Shope Brick Co., manufacturer of cement brick products, has received a contract for the erection of a plant for the Chinese Government at Canton, China, to be equipped for an initial production of about 125,000 bricks per day. Machinery will be constructed and transported to the site in the near future. D. F. Shope is president.

Pennsylvania

NEW CASTLE—F. A. Seiberling, former president of the Goodyear Tire & Rubber Co. and now operating a local plant under the name of the Lehigh Tire & Rubber Co., has organized a new company under Delaware laws, to be known as the Seiberling Rubber Co., capitalized at $55,000,000, to manufacture tires and other rubber products. Arrangements have been perfected for the purchase of the plant and business of the Portage Tire & Rubber Co., operating under a receivership for a number of months past, for a consideration said to be close to $1,000,000. This plant will be operated in conjunction with the New Castle works, representing two manufacturing units of the new Seiberling Co.

PITTSBURGH—The Aluminum Co. of America, Oliver Bldg., has tentative plans under way for the construction of a new hydro-electric power plant in the vicinity of Long Sault Rapids, N. Y., to be used for works operating service in this district. F. S. Fickes, company address, is engineer.

SHIPPENPORT—Fire, Nov. 16, destroyed a portion of the local oil works of the Southwest Pennsylvania Pipe Lines Co., a subsidiary of the Standard Oil Co., with loss estimated at about $35,000.

PITTSBURGH—The Standard Envelope Mfg. Co. has leased space in the new Chatfield & Woods Bldg., Second Ave. and Short St., for expansion.

LANCASTER—The Armstrong Cork Co. has construction under way on a 1-story shop addition at its local plant, 25 x 35 ft., at Liberty and Mary Sts.

PHILADELPHIA — The Metzger Co., Fifth and Federal Sts., glass products, has filed plans for the erection of a 3-story plant addition, 35 x 68 ft., to cost about $17,000.

Tennessee

CHATTANOOGA—The new works to be constructed by the Ocoee Copper Co., 1135 Volunteer Life Bldg., at Ducktown, Tenn., will include an extensive flotation plant for the treating of copper ores. The entire works will cost about $200,000. J. I. Carter is president.

Texas

WACO—The Morris Oil Refining Co. has commenced preliminary production at its new refinery at South Bosque, near Waco, and proposes to develop a capacity of about 1,000 bbl. a day. R. E. Whitlock is manager.

CISCO—Homer Peeples, operating in the Callahan field, near Cisco, has plans under way for the construction of a new casinghead gasoline plant to serve the different properties in this district.

West Virginia

WESTON—The Interstate Window Glass Co. is planning for the rebuilding of its local plant, recently partly destroyed by fire, with loss estimated at about $25,000.

Canada

BRITANNIA BEACH, B. C.—The Britannia Mining & Smelting Co. is planning for the early rebuilding of its smelting works, recently damaged by flood, and has awarded a contract to the Traylor Engineering & Mfg. Co., Allentown, Pa., for the construction of 18 large tube mills and 5 sets of crushing rolls, the largest to be 72 in. in diameter. The machinery is expected to be ready for shipment in about 90 days.

New Publications

Industrial India is the title of a new monthly magazine published for distribution among the industries of India by the Tata Publicity Corp., Ltd., London. This is the first attempt to produce a modern industrial magazine for India, and the publication should be of interest to those who are developing the Indian market.

THE IMPERIAL MINERAL RESOURCES BUREAU, London, England, has published the following bulletins, on Talc: Fluorspar; Coal, Coke and Byproducts; Tungsten and Manganese.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: Mineral Resources of the U. S. in 1920 (Preliminary Summary); I:1, Cadmium in 1920, by C. E. Siebenthal and A. Stoll (Mineral Resources of the U. S., 1920, Part I), published May 12, 1921; I:2, Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1920, by J. P. Dunlop (Mineral Resources of the U. S., 1920, Part I), published Aug. 13, 1921; I:4, Chromite in 1920, by Edward Sampson (Mineral Resources of the U. S., 1920, Part I), published Aug. 17, 1921; I:5, Bauxite and Aluminum in 1920, by James M. Hill (Mineral Resources of the U. S., 1920, Part I), published Aug. 31, 1921; I:6, Platinum and Allied Metals in 1920, by James M. Hill (Mineral Resources of the U. S., 1920, Part I), published Sept. 9, 1921; I:7, Arsenic, Bismuth, Selenium and Tellurium in 1920, by Victor C. Heikes (Mineral Resources of the U. S., 1920, Part I), published Sept. 22, 1921; I:13, Silver, Copper, Lead and Zinc in the Central States in 1919, by J. P. Dunlop (Mineral Resources of the U. S., 1919, Part I), published May 25, 1921; I:16, Gold, Silver, Copper, Lead and Zinc in Arizona in 1919, by V. C. Heikes (Mineral Resources of the U. S., 1919, Part I), published Aug. 12, 1921; I:17, Gold, Silver, Copper, Lead and Zinc in Nevada in 1919, by V. C. Heikes (Mineral Resources of the U. S. 1919, Part I), published Aug. 16, 1921; I:18, Gold, Silver, Copper, Lead and Zinc in Utah in 1919, by V. C. Heikes (Mineral Resources of the U. S., 1919, Part I), published Aug. 9, 1921; I:19, Gold, Silver, Copper, Lead and Zinc and Idaho and Washington in 1919, by C. N. Gerry (Mineral Resources of the U. S. 1919, Part I), published Aug. 11, 1921; I:20, Gold, Silver, Copper, Lead and Zinc in Montana in 1919, by C. N. Gerry (Mineral Resources of the U. S., 1919, Part I), published Aug. 17, 1921; I:21, Copper in 1919, by H. A. C. Jenison (Mineral Resources of the U. S., 1919, Part I), published Sept. 8, 1921; I:31, Zinc in 1918, by C. E. Siebenthal (Mineral Resources of the U. S., 1918, Part I), published April 29, 1921; I:B, Mineral Resources of the United States in 1918, Introduction by Edson S. Bastin, summary by Martha B. Clark (Mineral Resources of the U. S., 1918, Part I), published Aug. 15, 1921; II:1, Magnesite in 1920 by Charles G. Yale and Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published July 27, 1921; II:2, Salt, Bromine and Calcium Chloride in 1920 by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published Aug. 5, 1921; II:3, Phosphate Rock in 1920, by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published in Aug. 11, 1921; II:4, Sand-Lime Brick in 1920, by Jefferson Middleton (Mineral Resources of the U. S., 1920, Part II), published Aug. 24, 1921; II:5, Fullers Earth in 1920, by Jefferson Middleton (Mineral Resources of the U. S., 1920, Part II), published Aug. 25, 1921; II:6, Peat in 1920, by K. W. Cottrell (Mineral Resources of the U. S., 1920, Part II), published Sept. 7, 1921; II:7, Asphalt and Related Bitumens in 1920, by K. W. Cottrell (Mineral Resources of the U. S., 1920, Part II), published Aug. 25, 1921; II:8, Gypsum in 1920, by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published Aug. 31, 1921; II:9, Fluorspar and Cryolite in 1920, by Hubert W. Davis (Mineral Resources of the U. S., 1920, Part II), published Sept. 20, 1921; II:10, Graphite in 1920, by L. M. Beach (Mineral Resources of the U. S., 1920, Part II), published Sept. 16, 1921; II:11, Fuel Briquets in 1920, by W. P. McKenny (Mineral Resources of the U. S., 1920, Part II), published Sept. 19, 1921; II:12, Strontium in 1920, by George W. Stose (Mineral Resources of the U. S., 1920, Part II), published Sept. 17, 1921; II:20, Asphalt and Related Bitumens in 1919, by K. W. Cottrell (Mineral Resources of the U. S. 1919, Part II), published July 18, 1921; II:21, Asbestos in 1919, by J. S. Diller (Mineral Resources of the U. S., 1919, Part II), published May 14, 1921; II:22, Concrete Stone and Concrete Blocks in 1919, by G F. Loughlin and M. E. McCaslin (Mineral Resources of the U. S., 1919, Part II), published July 27, 1921; II:28, Silica in 1919, by L. M. Beach (Mineral Resources of the U. S., 1919, Part II), published Aug. 27, 1921; II:24, Barytes and Barium Products in 1919, by George W. Stose (Mineral Resources of the U. S., 1919, Part II), published July 28, 1921; II:25, Fluorspar and Cryolite in 1919, by Hubert W. Davis (Mineral Resources of the U. S., 1919, Part II), published July 20, 1921; II:27, Feldspar in 1919, by L. M. Beach (Mineral Resources of the U. S., 1919, Part II), published Aug. 12, 1921; II:30, Cement in 1919, by Ernest F. Burchard (Mineral Resources of the U. S., 1919, Part II), published Sept. 21, 1921.

THE MOSSBACHER CO., New York, N. Y., has been incorporated with a nominal capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are R. and J. Kraus, and S. S. Mossbacher, New York. The company is represented by Max Silverstein, 309 Broadway.

New Companies

THE VERA CHEMICAL CO., Stoneham, Mass., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. Wilfred H. Smart is president; and Peter F. McCarty, 8 Winter St., Boston, Mass., treasurer.

THE STRAITS RUBBER CO., Detroit, Mich., has been incorporated with a capital of $20,000, to manufacture rubber products. The incorporators are A. E. Severance, K. H. and E. R. Glanton, 3765 Philadelphia St., West, Detroit.

THE ANALGOL CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are M. and A. Saracena, and Luigi Miscione, 291 Broadway, New York.

THE CELLULOSE CORP., Newark, N. J., has been incorporated with a capital of $5,000, to manufacture cellulose specialties, celluloid products, etc. The incorporators are Eugene Berry, E. Moore and John C. Wasserbach, 78 Park St., Newark.

THE TITAN ABRASIVES CO., Room 610, 139 North Clark St., Chicago, has been incorporated with a capital of $10,000, to manufacture abrasive products. The incorporators are Roland R. Hurford, A. B. Singleman and Albert J. Doermann.

FRED STERN & CO., INC., New York, has been incorporated with a capital of $1,000,000, to manufacture rubber products, gutta percha specialties, etc. The incorporators are Fred Stern, J. S. Kane and L. H. Heyworth. Offices of the company are at 277 Broadway.

THE KEYSTONE CARBONIC GAS CO., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $2,000,000, to manufacture carbonic acid gas and kindred products. The incorporators are S. S. Bailey, Pittsburgh; J. H. Loller and T. B. Donnelly, Connellsville, Pa. The company is represented by the Capital Trust Co., Dover, Del.

THE TEMPLE COTTON OIL CO., Hope, Ark., has been incorporated with a capital of $1,000,000, to manufacture cotton oil and affiliated products. H. A. Carpenter is president; F. O. Colleman, vice-president; and R. L. White, secretary and treasurer, all of Hope.

THE NORTH AMERICAN RUBBER CORP., 508 Union Bank Bldg., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture rubber products. The incorporators are L. E. Kraft, C. W. Breisford and John C. Brown.

THE ECLIPSE MFG. CO., Pawtucket, R. I., has been incorporated with a capital of $25,000, to manufacture polishes, paste, and kindred specialties. The incorporators are William H. Gough, Arthur Mellor and John W. Hadfield, 191 East Ave., Pawtucket.

THE AMERICAN NATIONAL PETROLEUM CO., New York, N. Y., has been incorporated with a capital of $4,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE CYRUS CHEMICAL CO., South River, N. J., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are James R. McCoy, A. L. Giles and Cyrus Butler, South River.

THE SOUTH FLORIDA OIL CO., Tampa, Fla., has been incorporated with a capital of $50,000, to manufacture oil products. Earl H. McRae is president; John A. Gallagher, vice-president; and Edward A. Kitchen, secretary and treasurer, all of Tampa.

THE SCRANTON COLOR & CHEMICAL CO., Scranton, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture chemicals and affiliated products. The company is represented by the Corporation Service Co., Wilmington, Del.

THE PORCELIZED METAL CO., Buffalo, N. Y., has been incorporated with a capital of $150,000, to manufacture special porcelain compounded metal products. The incorporators are J. B. Devine and A. B. Taylor. The company is represented by D. F. Strebel, Marine Bank Bldg., Buffalo.

THE LONG-WEAR TIRE & RUBBER CO., Anderson, Ind., has been incorporated with a capital of $300,000, to manufacture tires and other rubber products. The incorporators are B. B. Benner, Albert Anderson, Ernest Bond, and Nathan Ridgway, all of Anderson.

THE PITTMAN CHEMICAL CO., Birmingham, Ala., has been organized under state laws to manufacture chemicals and chemical byproducts. F. M. Pittman is president and general manager; R. L. Lange, vice-president; and M. I. Pittman, secretary, all of Birmingham.

THE PARAFLEX RUBBER CORP., New York, N. Y., has been incorporated with a capital of $30,000, to manufacture rubber products of various kinds. The incorporators are A. W. Palmer and V. A. Roberts. The company is represented by Merrell, Bates & Topping, 27 Cedar St., New York.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Emerson Hotel.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN PETROLEUM INSTITUTE will hold its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

COLLEGE OF THE CITY OF NEW YORK, department of chemistry, will give public lectures under the auspices of the City College Chemical Society in the Doremus Lecture Theater, at 4:30 p.m., as follows: Nov. 30, "Afterthoughts of the War," by Leland L. Summers, of the War Industries Board; Dec. 6, "America in Chemistry," by Dr. Edgar F. Smith, provost emeritus, University of Pennsylvania, and president, American Chemical Society.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting. Jan. 6—American Chemical Society, regular meeting; Jan 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.